SPECIAL INSERT: **SUMMER ASTRO ACTIVITY GUIDE**

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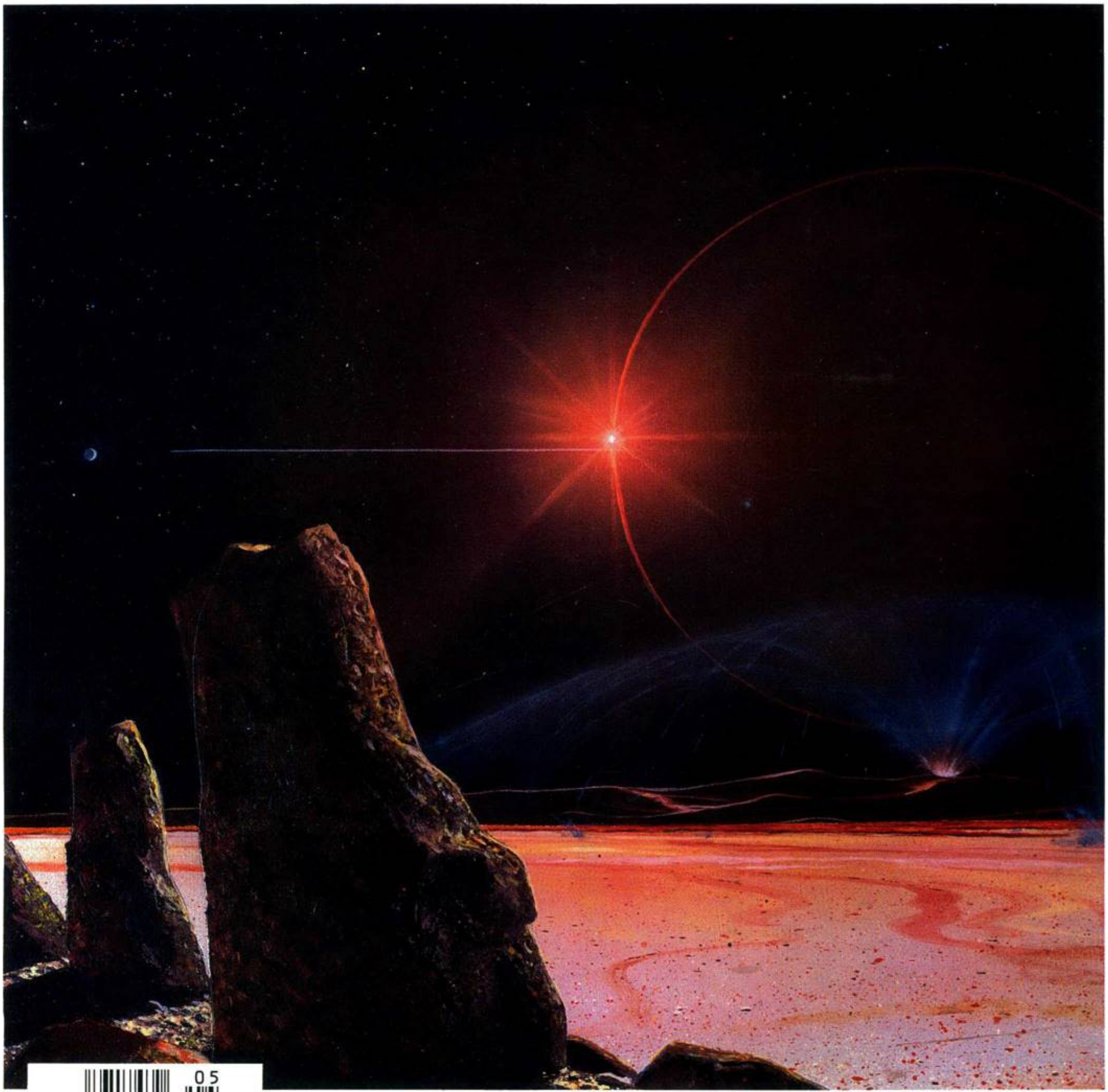

Violent Volcanos of Io

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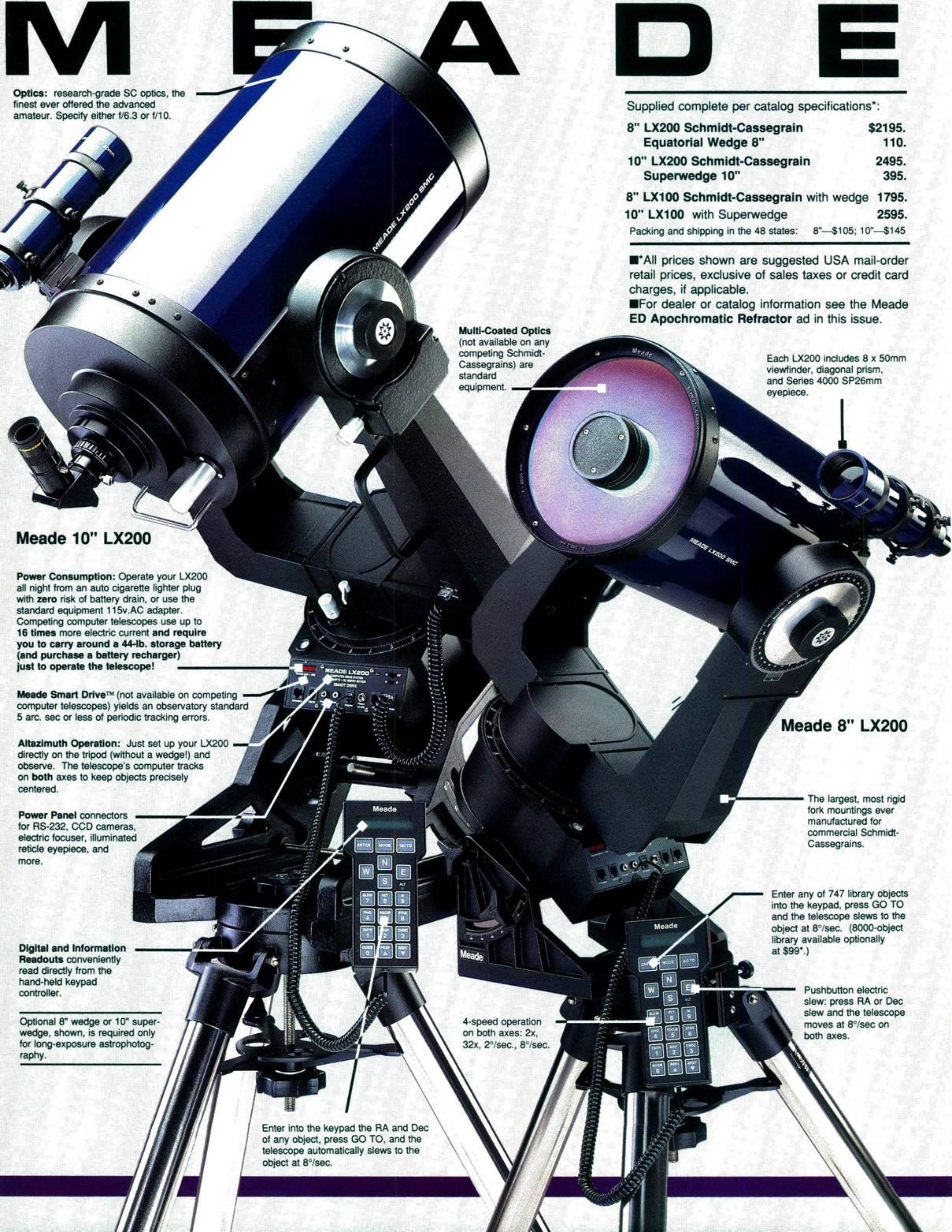

Optics: research-grade SC optics, the finest ever offered the advanced amateur. Specify either f/6.3 or f/10.

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8" LX200 Schmidt-Cassegrain	**$2195.**
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Superwedge 10"	**395.**
8" LX100 Schmidt-Cassegrain with wedge	**1795.**
10" LX100 with Superwedge	**2595.**
Packing and shipping in the 48 states:	8"—$105; 10"—$145

■*All prices shown are suggested USA mail-order retail prices, exclusive of sales taxes or credit card charges, if applicable.

■For dealer or catalog information see the Meade **ED Apochromatic Refractor** ad in this issue.

Multi-Coated Optics (not available on any competing Schmidt-Cassegrains) are standard equipment.

Each LX200 includes 8 x 50mm viewfinder, diagonal prism, and Series 4000 SP26mm eyepiece.

Meade 10" LX200

Power Consumption: Operate your LX200 all night from an auto cigarette lighter plug with **zero** risk of battery drain, or use the standard equipment 115v.AC adapter. Competing computer telescopes use up to **16 times** more electric current **and require you to carry around a 44-lb. storage battery (and purchase a battery recharger) just to operate the telescope!**

Meade Smart Drive™ (not available on competing computer telescopes) yields an observatory standard 5 arc. sec or less of periodic tracking errors.

Altazimuth Operation: Just set up your LX200 directly on the tripod (without a wedge!) and observe. The telescope's computer tracks on **both** axes to keep objects precisely centered.

Power Panel connectors for RS-232, CCD cameras, electric focuser, illuminated reticle eyepiece, and more.

Digital and Information Readouts conveniently read directly from the hand-held keypad controller.

Optional 8" wedge or 10" superwedge, shown, is required only for long-exposure astrophotography.

Meade 8" LX200

The largest, most rigid fork mountings ever manufactured for commercial Schmidt-Cassegrains.

Enter any of 747 library objects into the keypad, press GO TO and the telescope slews to the object at 8°/sec. (8000-object library available optionally at $99*.)

Pushbutton electric slew: press RA or Dec slew and the telescope moves at 8°/sec on both axes.

4-speed operation on both axes: 2x, 32x, 2°/sec., 8°/sec.

Enter into the keypad the RA and Dec of any object, press GO TO, and the telescope automatically slews to the object at 8°/sec.

LX200 SCHMIDT-CASSEGRAINS

The largest-selling serious telescopes in the world.

Now you can buy the most advanced 8" and 10" Schmidt-Cassegrains ever produced, at a price directly competitive with other SCT's offering only a fraction of the features!

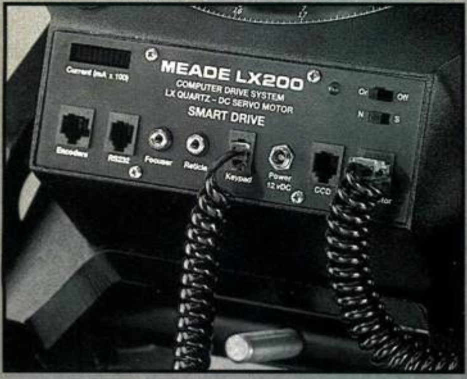
Meade LX200 SCT's offer a revolutionary departure from any other SCT's ever made available. Consider the **standard specifications** of these telescopes:

New Heavy-Duty Fork Mounts—The largest, most rigid in the industry. *Meade 8" and 10" LX200 fork mounts yield the lowest damping times of any SC fork mounts available.* Large 4"-diameter polar ball bearings complemented by DC-servo-motor-driven worm gears on ***both*** telescope axes permit observatory-level precision in tracking, guiding, and slewing.

100% Computer-Controlled Operation—All-new Meade LX200 microprocessor-controlled drive systems offer an incredible array of features:

■**Four-speed operation on both telescope axes** simultaneously, including (a) photo-guiding (at **2x** sidereal rate); (b) image centering and microslewing in the main telescope (at **32x** sidereal rate); (c) image centering in the view-finder (at **2**° per sec.); or fast-slew of the main telescope across the skies (at **8**° per sec.).

■**Pushbutton Electric Slew**—Press RA or Dec slew, east or west, north or south, and the telescope moves at 8° per sec. on both axes. As you near a desired object, flip to 2° per sec. slew, to center the object in the field. The observer need never touch the telescope in moving from one object to another. (Of course, if you wish, the telescope may be moved manually as well.)



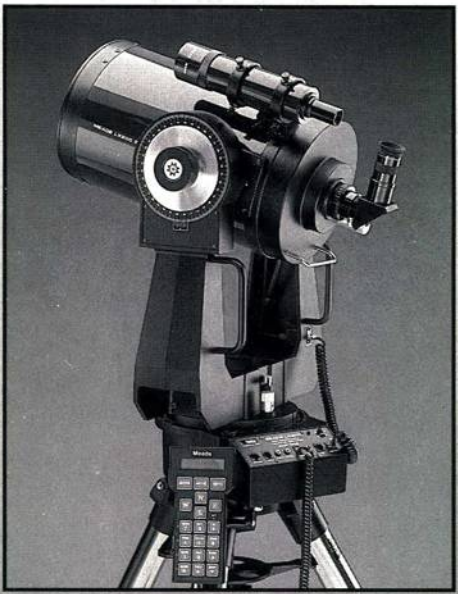
■**Digital Readouts** on both axes, read from the handheld Electronic Command Center (ECC).

■**GO TO Capability**—Enter the RA and Dec of an object into the keypad of the ECC, press GO TO, and the telescope automatically slews to the object at 8° per sec., centering it in the field.

■**747-Object Built-in Library**—Enter any of the 110 Messier objects, 278 of the finest NGC objects, 351 stars (doubles, variables, polar reference stars), or one of the 8 planets, from Mercury to Pluto, press GO TO, and the telescope slews at 8° per sec. to the object with uncanny precision. For $99* add the 8000-object Meade CNGC library, a 30-second plug-in.

■**Permanently programmable (PPEC) Smart Drive**™, capable of reducing periodic drive errors to 5 arc. sec. or less.

Legendary Meade Super Multi-Coated f/6.3 or f/10 Schmidt-Cassegrain Optics—Now you can choose either wide-field f/6.3 or classical f/10 Meade US-made SC optics **at the same price.** Either way, you'll be buying the finest Schmidt-Cassegrain optical system available, a system that yields razor-sharp stellar images and high-resolution observing of the Moon, planets, and deep-space, from the World's leading manufacturer. Meade exclusive Super Multi-Coatings on both sides of the correcting plate assure maximum light transmission and contrast.



Altazimuth Mode Operation—For all visual observing applications, and for lunar and planetary photography, Meade LX200's may be set up in the altazimuth mode, without any equatorial wedge—just attach the telescope's drive base directly to the tripod, use the fast 1-star alignment procedure, and the telescope's computer actuates 2-axis tracking that keeps objects precisely centered in the field, even at high powers, during the entire observing session. For long exposure photography (longer than about 5 minutes) altazimuth-induced field rotation requires an equatorial wedge, which may be purchased separately.

Fast Polar Alignment—Center two reference stars in the telescopic field and the telescope's computer tells you exactly what telescope controls to actuate for precise polar alignment in the equatorial mode in less than a minute.

The widest array of keypad and power-panel control functions—In addition to the microprocessor-controlled operations listed above, the handheld ECC and the telescope's power panel permit: readout of sidereal or local time; actuation of the optional electric focuser; crossline brightness control of an illuminated reticle eyepiece; direct plug-in of popular CCD autoguiders/imagers; and more than 14 other telescope functions.

MEADE LX100 SCHMIDT-CASSEGRAINS

Observers not requiring the sophistication of the LX200 electronics may wish to consider an 8" or 10" LX100 model SCT instead. Meade LX100's include the exact same heavy-duty fork mounts of their LX200 counterparts, but with a microfine declination tangent arm control in place of the LX200's motorized worm gear, and with a 2-speed drive in place of the LX200's 4-speed drive; optical tubes and coatings are identical. Standard LX100 features include:

■ Handheld Electronic Command Center—With 2-speed operation, **2x** for photo-guiding and **32x** for image centering and microslewing in the main telescope. (With the optional DC-servo declination motor installed, these speeds are operational on both telescope axes.)

■ Permanently programmable (PPEC) Smart Drive, as described above.

Complete LX100 and LX200 Telescopes

Specifications: 8" and 10" LX200's—Each complete telescope includes: 8" or 10" SC optical tube assembly (specify f/6.3 or f/10) with super multi-coatings; heavy-duty fork mount, with 4" polar ball bearing, dual-axis 5.75" worm-gears, and multi-function power panel display on the drive base; manual slow-motion controls on both axes; handheld keypad Electronic Command Center, with digital readout display, PPEC Smart Drive, four-speed drive control on both axes, GO TO controller, and 747-object software library; 25 ft. power cords for telescope operation from either 12 v. DC auto cigarette lighter plug or 115v.AC; 8 x 50mm viewfinder with crosshairs; diagonal prism (1.25"); Series 4000 Super Plössl 26mm eyepiece; variable-height field tripod; new deluxe die-cut-foam-fitted carrying case; complete operating instructions.

Specifications: 8" and 10" LX100's—Each complete telescope includes 8" or 10" SC optical tube assembly (specify f/6.3 or f/10) with super multi-coatings; heavy-duty fork mount with 4" polar ball bearing, 5.75" RA worm gear, and multi-function power panel display on the drive base; manual slow-motion controls on both axes; handheld pushbutton Electronic Command Center with PPEC Smart Drive and 2-speed drive control; 25 ft. power cords for telescope operation from either 12v. DC auto cigarette lighter plug or from 115v. AC; viewfinder: 6 x 30mm (8") or 8 x 50mm (10"); diagonal prism (1.25"); Series 4000 Plössl 26mm eyepiece; variable-height field tripod; equatorial wedge (8") or Superwedge (10"); new deluxe die-cut-foam-fitted carrying case; complete operating instructions.

For the beginner, or for the most seasoned observer, Meade LX200's are the most user-friendly telescopes ever manufactured. First-time telescope users **almost uniformly** remark that "I saw **hundreds** of deep-space objects my very first night out!" Advanced amateurs report that "the LX200 found objects during my first observing session that I was unable to locate in over 20 years of serious observing with other telescopes."

Contact your authorized Meade dealer today. See for yourself why Meade LX200's are the largest-selling serious telescopes in the world.

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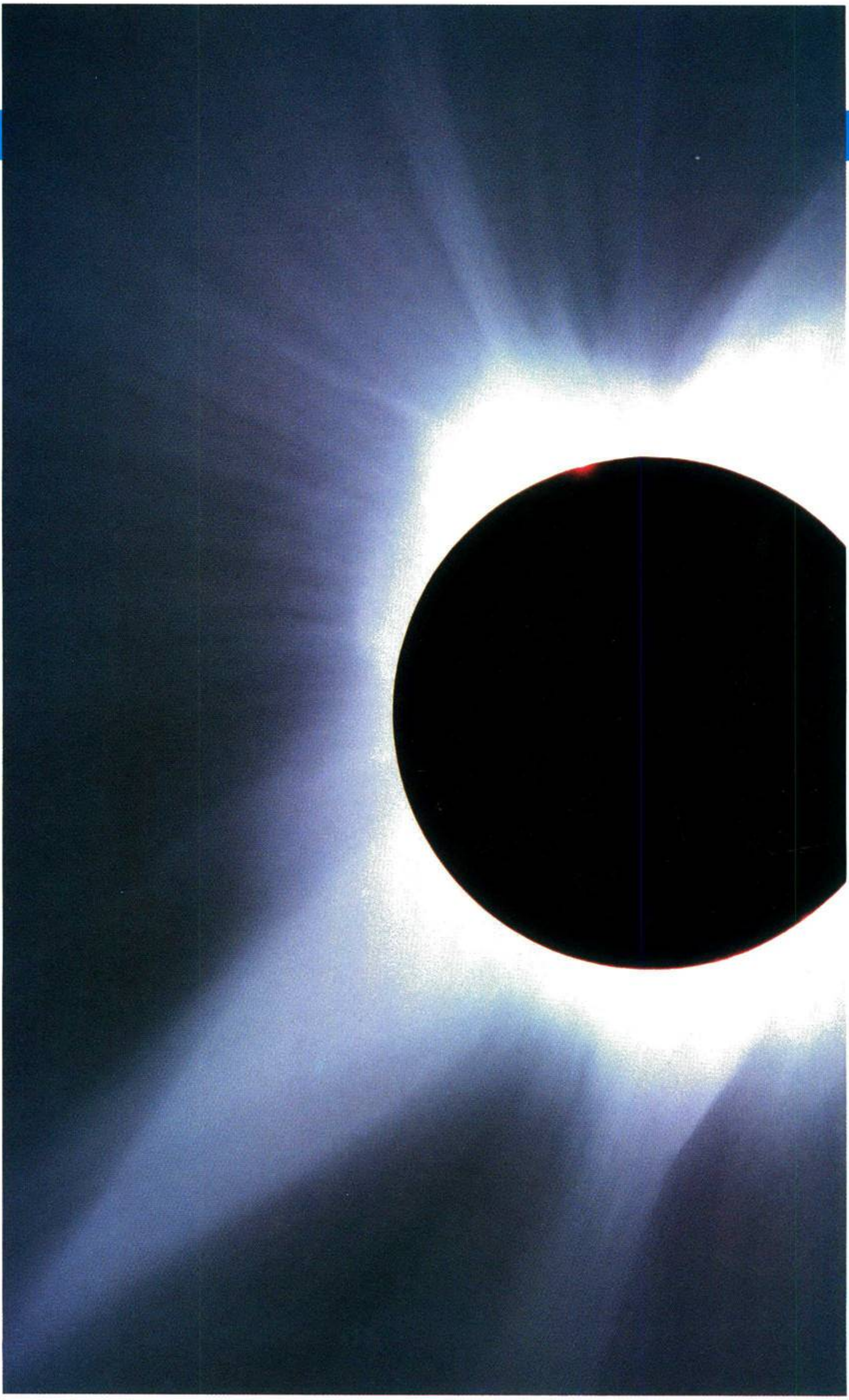
ON THE COVER: A volcano erupts on Jupiter's moon Io, shooting a huge plume of volcanic debris high into the thin atmosphere. This geologically tortured world — the most volcanically active in the solar system — stands in stark contrast to the cold, gaseous planet it circles. Illustration by William K. Hartmann and Ron Miller.



Roland Christen

PEARLY WHITE STREAMERS HIGHLIGHT the solar corona, the Sun's superhot outer atmosphere. Recent X-ray observations are helping astronomers zero in on how the corona gets so hot. For more, see page 26.

20th ANNIVERSARY YEAR
ASTRONOMY

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The Audit Bureau

Behind the Scenes

GEARING UP FOR OBSERVING

By the time you read this, spring will be marching right along. Amateur astronomers across the southern United States will have been active for months, if not during the whole winter. But for a great many backyard astronomers up here in the northern states and in Canada, observing season is just getting underway in earnest.

Now's the time to tune up the telescope, tweak the optics, and dust off the eyepieces. Now's the time to scan the ads and get serious about those accessories you've been eyeing since last fall.

May nights are wonderfully varied. The stars of spring shine in the evening but by midnight summer's on display. In a few hours you can go from exploring the galaxies of Virgo to prowling the starclouds of our own Galaxy. May is also the month when star parties, national and local, begin to sprout thickly (see page 16). The Texas Star Party and the Riverside Telescope Maker's Conference are large and well known, but in many localities you'll find meetings scheduled every weekend from now into late autumn.

To help get you warmed up for the season, we feature a tour of a region few amateurs really explore: Bootes the Herdsman and its immediate environs. You may know Arcturus, but if that's all you know, you've missed some neat stuff.

Then we invite those with 6-inch or larger scopes to try for Pluto, an object few people ever think they can see. Until 1999 Pluto lies closer to the Sun than Neptune, so technically it isn't accurate to call Pluto the most-distant planet. But that's quibbling — every amateur astronomer knows that finding Pluto lets you brag to your friends at least a little.

Two other stories this month will help you explore the sky in a different way — with film and a camera. First, consider Pete Ramberg's Schmidt camera. This easy-to-build (yes!) project gives you an instrument ideal for capturing deep-sky objects quickly, plus you can modify it for visual use. Best of all, you don't have to make a corrector plate.

Taking a different approach to seeing more, Kim Zussman tells all about boosting the response of film by hypersensitizing it. "Hypering" is a clever trick experienced astrophotographers use to kick their film into high gear. It can't pull in objects that are truly fainter-than-faint, but it will let you use fine-grained films for photos that have maximum impact.

Lastly, don't forget about Astronomy Day. This year it's held on two Saturdays, April 24 and May 1. (In between is Astronomy Week, of course.) Why not help a group in your area get the word out to those who are as fascinated about the universe as you are, but who don't know how to get started. Wondering where to turn? Just look in the special directory you'll find in the center of this issue for a club or group in your area.

Sincerely,

Robert Burnham
Editor

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Letters

Who's Fixing Whom?

In the article "How We'll Fix Hubble" by Greg Davidson (February 1993) I read that "scientists also have proprietary rights to their data for a year."

The Hubble Space Telescope was constructed and launched and will be repaired at the expense of taxpayers. Beyond necessary shakedown and processing time, observations should be made immediately available to the public. I am 77 years old and have few sentient years left. Why should I be deprived because a scientist is worried that some Galileo will appear and use his or her data while the scientist is still playing with the photons? — *Morgan C. Larkin, Salem, Oregon*

Mirror Memories

I was fascinated by William J. McPeak's article "Building the Glass Giant of Palomar" (December 1992). As McPeak explained, the first casting of the 200-inch mirror was ruined when several of the supports melted and floated to the surface of the mirror. That failed casting is now on display at the Corning Glass Museum in Corning, New York. It's hard to appreciate the sheer size of the 200-inch mirror until you see that one solid piece of glass up close. Several years ago, during a visit to California, I made a point of making the trip up 7,500-foot Palomar Mountain just so that I could say I have now seen both castings of the mirror. — *J. Robert Huston, Mt. Holly, New Jersey*

William McPeak provided a fine trip back in time in his article on the construction of the 200-inch Hale Telescope. I was one of those lucky kids who lived around the corner from Caltech during the mirror-grinding years. An observation gallery overlooked the optical lab and a lot of us kids found it a fascinating place to visit. A year ago when I dropped by the campus, the aura seemed to be there still. — *Robert W. Russell, Astoria, Oregon*

Mighty Meteor

I've been an amateur astronomer since the 1950s and have seen many incredible sights. But the most unusual occurred in June 1962 near the Cincinnati suberb of Forest Park, when I was seventeen. I saw an incredible bolide that fell from approximately the location of Polaris down to the northern horizon in about five to seven seconds. It followed a steep trajectory inclined about 20° to the meridian. I estimated its magnitude at

[continued on page 12]

550 BC: Anaximander invents the star chart.

1992 AD: The_Sky for Windows fine tunes the concept.

Now you can open your Windows to a whole new universe. A universe bursting with more stars and deep-sky objects than any other astronomy program devised since Anaximander himself first looked into the sky.

Because now, when you look into The_Sky for Windows you'll see 10,000, or 45,000, or even 272,000 objects, depending on which level you buy. Stars, planets, Messier and NGC objects, all of them easily identifiable.

And you'll warp through this universe, at speeds up to 100 times faster than the finest competing programs. Using our exclusive plotting technology, zoom to any portion of The_Sky you like in less than a second, with or without a math coprocessor.

It's a universe bursting with color, too. The_Sky powers your graphics hardware to its fullest potential, using any device supported by Windows, from CGA through 1024 x 768-pixel 256-color Super VGA and even beyond. No other program provides so wonderfully detailed or spectacularly colorful a show.

And speaking of spectacular, wait until you see the professional-quality star charts you can output to any Windows-supported printing device. Customize them to your own specifications by type, magnitude, constellation and/or grid lines, labels, SAO numbers — a galaxy of options.

There's one more option we doubt you'll ever want to use: a 60 day money back guarantee.

So remember. For the most dazzling display yet of the heavens on a computer, The_Sky's the limit.

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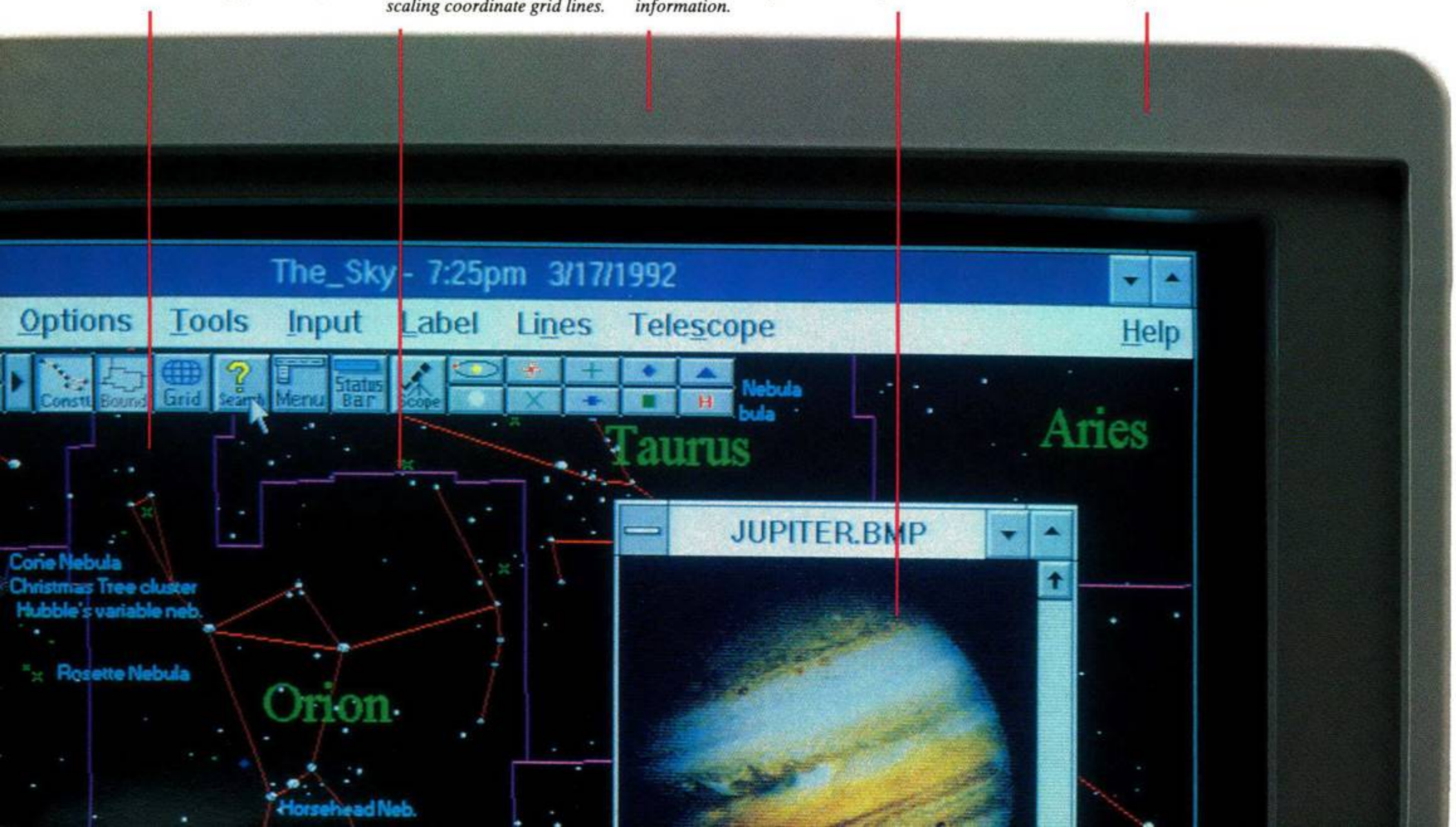
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Christmas Tree cluster
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Horsehead Neb.

Dynamically scroll and zoom through the sky. No more waiting for screen plots.

Quickly navigate the heavens using constellation lines and boundaries, auto-scaling coordinate grid lines.

Point and click on any object at any zoom level to display a wealth of detailed information.

Display full-color images of celestial objects — even add your own.

Enter time skips for fascinating shows of the planets in motion.

ACTUAL UNRETOUCHED PHOTOGRAPH

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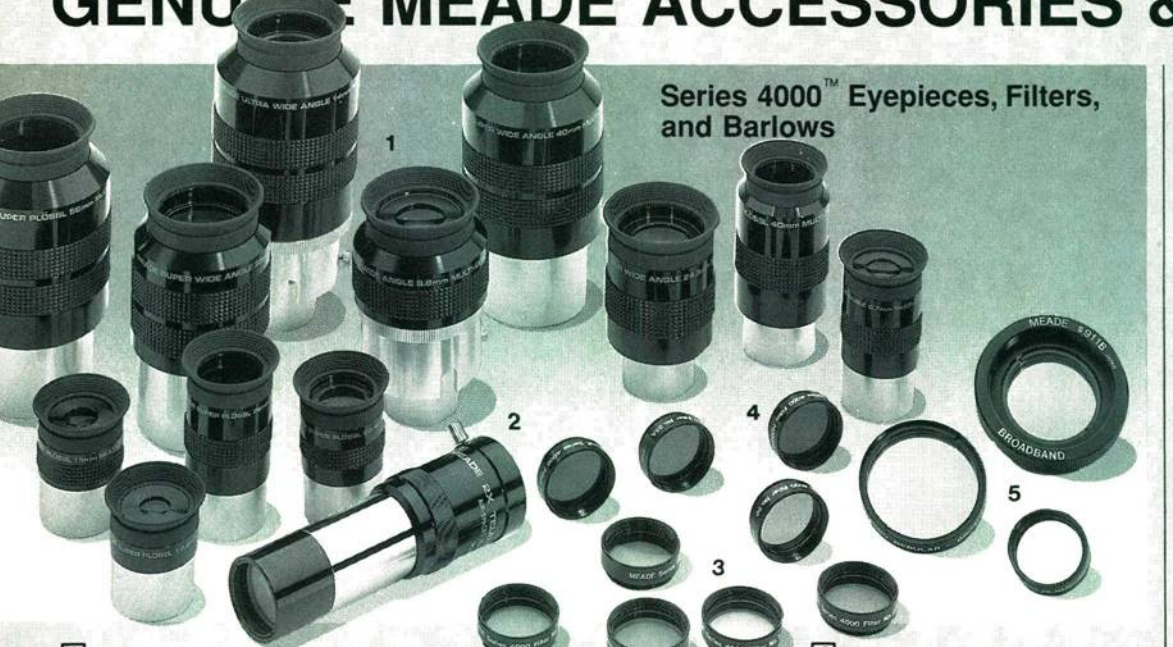

Series 4000™ Eyepieces, Filters, and Barlows

1 The World's finest telescope eyepieces now include rubber grips and soft rubber eyeguards for an even better observing experience! All eyeguards fold down for eyeglass wearers—a feature not available on competing brands. Best of all, **Meade Series 4000's are guaranteed to deliver more field, more contrast, and more image sharpness than any other brand at any price, or your money back.*** For splitting the closest doubles, revealing tenuous, faint nebulosity in deep-space, or studying hairline lunar and planetary detail, Meade multi-coated Series 4000's are the oculars that serious observers insist upon. ***"Clearly the best."***

Super Plössls (5-elements; 1.25"; 52°):
6.4; 9.7; 12.4; 15; 20; 26mm ea **$87.95** (3.29)
32mm(52°); 40mm(44°); each **109.95** (3.79)
56mm (52°, 2") **229.95** (4.18)

Super Wide Angles (6-elements; 1.25"; 67°):
13.8mm: 139.95 (3.29) **18mm: 149.95** (3.29)
24.5mm: 169.95 (3.79) **32mm(2"): 239.95** (4.18)
40mm(2"): 299.95 (4.18)

Ultra Wide Angles (8-elements, 1.25"; 84°):
4.7mm: 154.95 (3.29) **6.7mm: 187.95** (3.29)
8.8mm(1.25"/2"): **229.95** (4.18)
14mm(1.25"/2"): **269.95** (4.18)

*at participating dealers; see catalog for details.

2 **#140: Series 4000 2x Apochromatic Barlow Lens** (1.25")--The original Meade 3-element, air-spaced, multi-coated design. Absolutely unmatched in image resolution and color correction. 28mm dia. lens (26mm clear aperture). **$79.95** (3.29)

3 **Series 4000 Photo-Visual Color Filters** (1.25")—Made of purest crown optical glass, dyed in the mass. For increased contrast on the Moon and planets . Thread into virtually all 1.25" eyepieces sold today. Fully coated.

#8 Lt. Yellow; #11 Yellow-Green; #12 Yellow; #21 Orange; #23A Lt. Red; #25A Red; #38A Dark Blue; #47 Violet; #56 Lt. Green; #58 Green; #80A Blue; #82A Lt. Blue.
each **$12.95** (2.29)

Set #1—4 filters: #12 Yellow, #23A Lt.Red, #58 Green, #80A Blue **$49.95** (2.79)

Set #2—4 filters: #11 Yellow-Green, #25A Red, #47 Violet, #82A Lt. Blue **$49.95** (2.79)

Set #3—4 filters: #8 Lt. Yellow, #21 Orange, #38A Dark Blue, #56 Lt. Green **$49.95** (2.79)

Sets #1 & #2—8 filters **$89.95** (3.29)

Sets #1, #2, & #3—12 filters **$129.95** (3.48)

4 **Series 4000 Moon Filter** (1.25")—Excellent for 4" to 12" telescopes. Reduces Moon brightness by 87%. **$15.95** (2.49)

5 **Series 4000 Nebular Filters**—The very latest in multi-layer interference coating technology, Meade premium nebular filters are guaranteed to be the finest obtainable at any price. Use a Series 4000 Broadband filter to block most forms of light pollution, with minimal attenuation of desired wavelengths. Use a Narrowband filter in heavily light-polluted areas, or for extremely high contrast observing of faint nebulae.

BROADBAND FILTERS

#908B (1.25")—Threads into all Meade 1.25" eyepieces, and virtually all other brands. Full 26mm clear aperture. **$79.95** (2.49)

#910B—Threads into all Meade 2" eyepieces and most others; 44mm dia. **119.95** (2.79)

#911B--Threads on to the rear cell of Schmidt-Cassegrain telescopes. **99.95** (3.29)

NARROWBAND FILTERS

#908N (1.25")—Threads into virtually all 1.25" eyepieces; 26mm clear aperture. **89.95** (2.49)

#910N—Threads into all Meade 2" eyepieces and most others; 44mm dia. **129.95** (2.79)

#911N--Threads on to the rear cell of Schmidt-Cassegrain telescopes. **119.95** (3.29)

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The finest focusers in the industry. Meade rack and pinion mechanisms have precise, ultra-smooth action along the entire travel distance. Housings are machined for tight fit of the moving sleeve. All focuser models may be used on tubes of from 4" to 20" diameter; all accept 1.25" eyepieces. Mounting hardware included.

#71—The finest economical focuser available. Travel distance: 2.2" A precision mechanism, beautifully finished. **$44.95** (2.79)

#67—Includes spring-loaded gearbox for variable tension adjustment. Travel distance: 2.2". **59.95** (2.79)

Rack-and-Pinion Focusers (2")

#680--The most popular 2" focuser ever manufactured. Thousands in use. Spring-loaded gearbox; 3" travel. Includes 1.25" and 2" eyepiece-holders. **99.95** (3.78)

#682—Low-profile 2" focuser; body height only 1.75". Spring-loaded gearbox. Travel: 2.5". Includes 1.25" adapter. **99.95** (3.78)

Viewfinders: 30mm, 50mm, 60mm

#637: 6 x 30mm-Fine, 7° wide-field finder; coated, achromatic lens; crosshair eyepiece. 2-ring bracket with alignment screws. Attaches to tube diameters 6" to 12" **$49.95** (3.29)

#545: 8 x 50mm-(*lower photo*) Wide 5° field; coated achromatic objective; crosshair eyepiece. White tube. Ideal for telescopes of any aperture. See bracket below. **69.95** (4.28)

#544: 8 x 50mm--Same as #545, but in Meade blue. **69.95** (4.28)

#957: 9 x 60mm--(*top photo*) Collects 44% more light than 50mm; superior for faint objects; bracket below. **99.95** (4.68)

Bracket for 8 x 50mm: Fits Meade and Celestron SCT's, and other tubes from 7" to 20" diameter. **17.95** (2.79)

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Originally developed by Meade Instruments, these convenient diagonals erect the astronomical image, for terrestrial use of astronomical telescopes. Fully coated.

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#928: for 1.25" focusers.
#931 Hybrid: accepts 1.25" eyepieces, fits .965" focusers.

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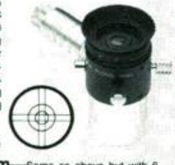

Series 4000 Plössl 9mm, with rubber eyecup and micrometric X-Y positioning of the reticle within the field. Greatly facilitates locking on the guide star. Sharp high-power imaging, excellent eye relief. Wireless red LED illuminator with adjustable brightness control. Internal batteries included. Multi-coated optics. Bullseye reticle. 1.25" **$129.95** (3.29)

Series 4000 Plössl 9mm—Same as above but with 6 ft. cord and plug for Meade LX3, LX5, LX6, LX100, LX200, and APO power panels, in place of wireless illuminator. **$109.95** (3.29)

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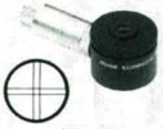

Excellent 3-element optical system, long eye relief, fully coated, with double crossline reticle. Includes wireless red LED illuminator with internal batteries and variable brightness control. **$94.95** (3.29)

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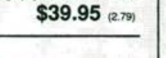

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#122: Doubles eyepiece power with sharp, high-resolution, high-contrast imaging on telescopes of all types. 27mm dia. (26mm clear aperture). Excellent corrections for chromatic and spherical aberrations at all photo-visual wavelengths. Multi-coated. 1.25" **$47.95** (3.29)

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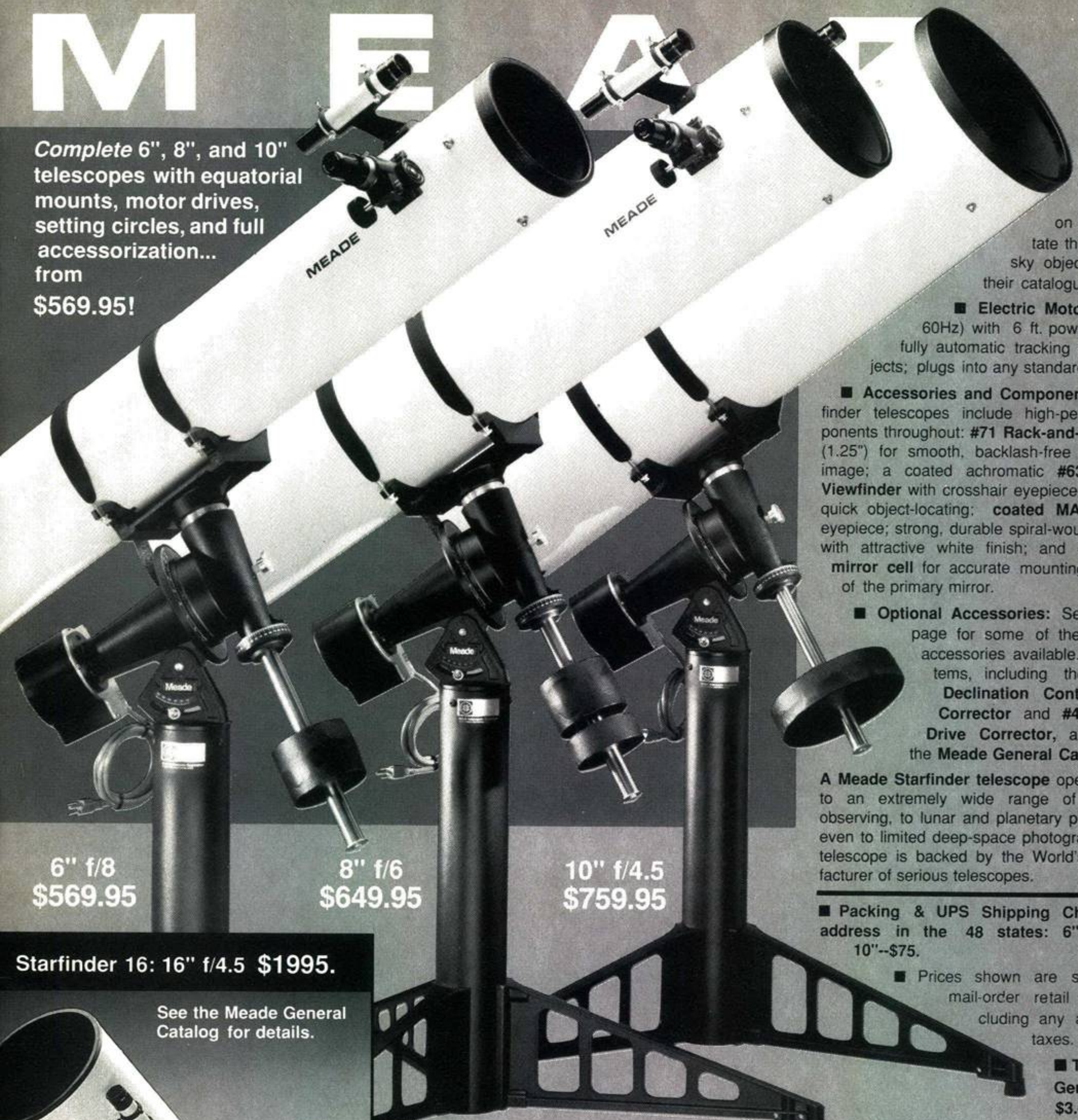

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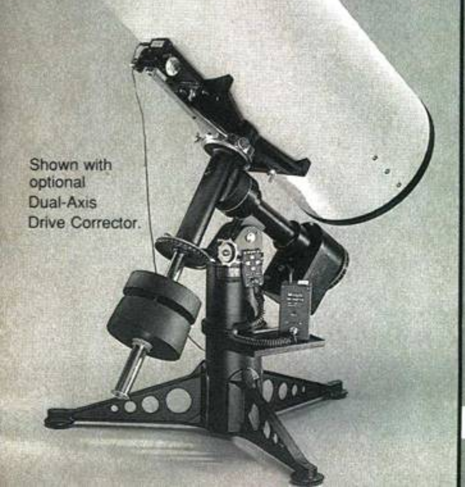

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Meade complete ED Apochromatic Refractors include optical tube assembly with giant 2.7" rack-and-pinion focuser, equatorial mount, field tripod, 8 x 50mm viewfinder, giant 2" diagonal mirror, and Super Plössl 26mm eyepiece:

4" f/9 Model 102ED, complete	**$1995.**
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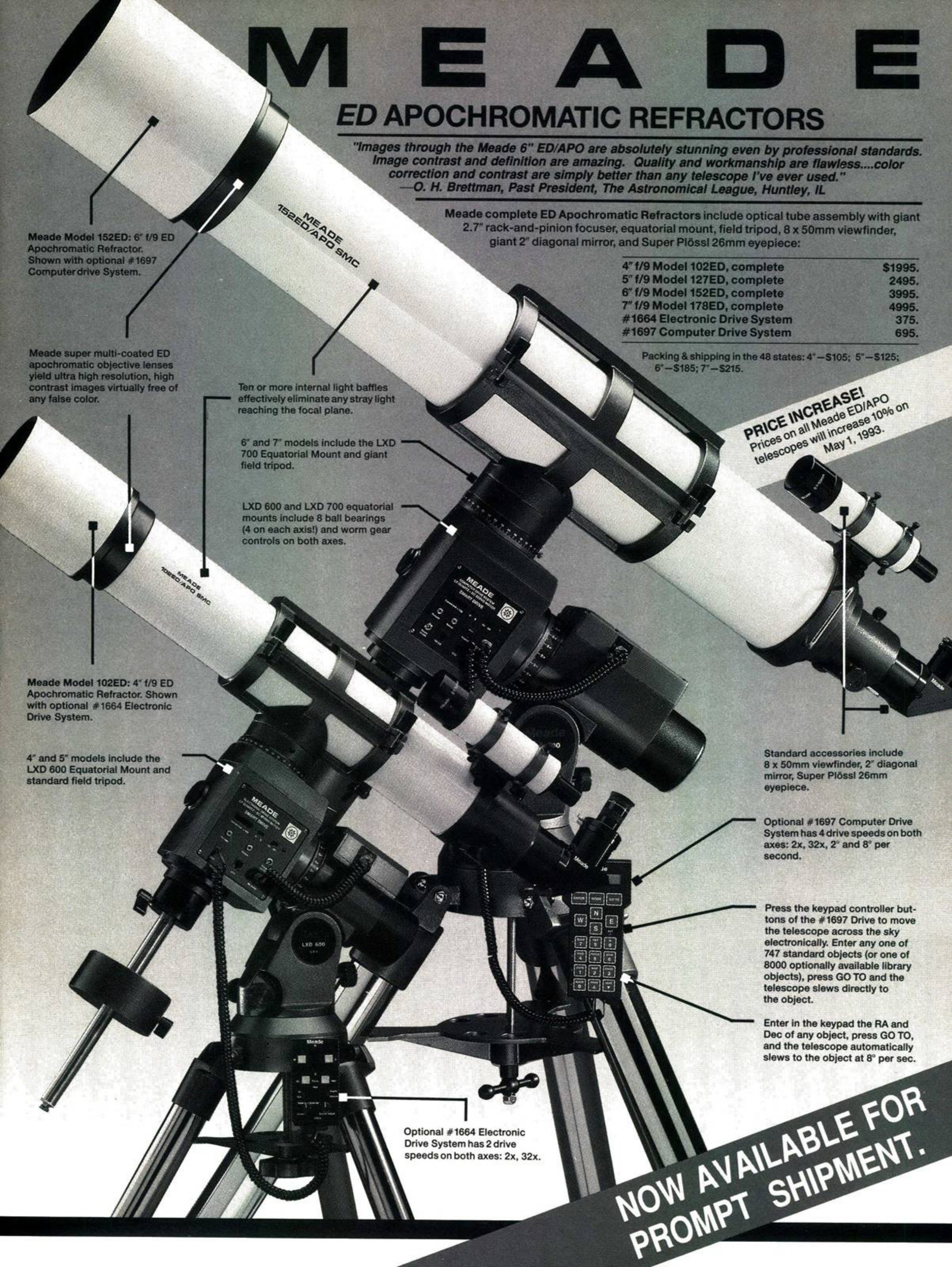

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LXD 600 and LXD 700 equatorial mounts include 8 ball bearings (4 on each axis!) and worm gear controls on both axes.

Meade Model 102ED: 4" f/9 ED Apochromatic Refractor. Shown with optional #1664 Electronic Drive System.

4" and 5" models include the LXD 600 Equatorial Mount and standard field tripod.

Standard accessories include 8 x 50mm viewfinder, 2" diagonal mirror, Super Plössl 26mm eyepiece.

Optional #1697 Computer Drive System has 4 drive speeds on both axes: 2x, 32x, 2° and 8° per second.

Press the keypad controller buttons of the #1697 Drive to move the telescope across the sky electronically. Enter any one of 747 standard objects (or one of 8000 optionally available library objects), press GO TO and the telescope slews directly to the object.

Enter in the keypad the RA and Dec of any object, press GO TO, and the telescope automatically slews to the object at 8° per sec.

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–4. It was yellow-white and apparently impacted a few miles north of Forest Park near what is now Fairfield, Ohio.

I've seen many meteors before and since, but this one was unique. It made a loud sizzling noise like frying bacon. It snapped, crackled, and popped from the top of its path down to the horizon, where the noise stopped instantly.

Do other ASTRONOMY readers have similar meteor experiences to share? — *Ralph W. Ballmer, Escondido, California*

Cells and Suns

In the October issue, Jon B. Slobins takes author Neil Comins to task for stating in his article "Life around a Larger Sun" (May 1992 issue) that "ionizing radiation has enough energy to separate the atoms in molecules, thus destroying the structure of living material. That's why exposure to too much X-ray radiation causes cancer and other diseases."

As a retired experimental oncologist, I see two minor faults with Comins' statement. "Altering" would have been a better word than "destroying," and he could have left out the qualifying "too much," since all ionizing radiation can cause cancer — a minor oversight in an astronomer's statement about biology and minor points in a field claiming to know how and when the universe began. — *Ira Pilgrim, Laytonville, California*

Is Anyone Out There?

I was impressed with Seth Shostak's article "Listening for Life" (October 1992). Shostak not only gave us an in-depth look at the SETI project, but revealed both the positive and negative aspects of the endeavor.

On the surface, the project looks like a big chance that will cost a lot of money. The business of searching for extraterrestrials is a slow one, and it could be many years before any communication takes place, if indeed it ever does.

But the benefits of the program outweigh the negatives. As other science programs have shown consistently and repeatedly, money spent on them comes back in other forms that benefit humans in unknowable ways. — *Ryland Metzinger, La Huba Heights, California*

Dark Lunar Eclipse

The total lunar eclipse of December 9, 1992, was the darkest I've seen in over 30 years of eclipse watching. It was a beautiful sight in my 8x50 binoculars, which I mounted on a camera tripod. Several stars were visible around the Moon throughout the eclipse. Just before and after totality I noticed a red-orange color near the edge of the umbra. A friend and I observed from the NASA/Goddard Optical Site in Beltsville, Maryland.

Just before totality we looked at Swift-Tuttle with the 8x50s and saw a 2° dust tail. We also observed the comet with an 8-inch f/11 reflector set up nearby. During moments of good seeing we observed structure in the inner coma. The south side of the coma appeared brighter than the north. We also saw a boomerang-shaped envelope near the central condensation that extended into the southern side of the coma during moments of good seeing. Overall the comet showed a surprising amount of detail, particularly in the telescope, and we were pleased that the jets were visible so easily.

The eclipse was great, and I rated it at L=0 on the Danjon scale of eclipse darkness. The eclipse's great darkness enabled us to observe Swift-Tuttle and see its full range of detail. — *George W. Gliba, Greenbelt, Maryland*

Simple Astrophotography

Mark Coco's article on simple astrophotography (November 1992) was extremely well done. I've been shooting the southern sky from Botswana for several years and thought I might suggest something useful for beginners.

During my early attempts I found that what appeared to be perfect shots were, on close inspection, sometimes flawed. In some cases the star images appeared circular, with a small "tail" attached. I initially thought this might be due to wind vibration, so I photographed only on calm nights. However, after using a great deal of film and running many tests for a lengthy period, I found the problem persisted and thought I might be vibrating the camera when the shutter opened. So I began holding a cover over the lens that could be taken away after the shutter opened. It worked.

My star images are now perfectly round, and I no longer waste any film. — *Colin Henshaw, Maunatlala, Botswana, Africa*

Correction

On page 65 of the January issue the photo of M77 should have been credited to James R. Foster. □

ASTRONOMY welcomes suggestions and additional information about articles and astronomy in general. Send your letter to ASTRONOMY Letters, P.O. Box 1612, Waukesha, WI 53187.

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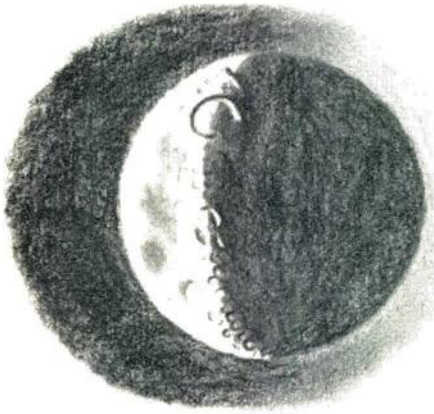

by Reinhart Claus

Ever wonder what it was like to observe through Galileo's telescope? Every view was a first, because no one else had pointed a telescope to the heavens. The sense of exhilaration must have been mixed with one of surprise as he viewed the Moon and planets. Galileo had no observing handbooks with pictures or descriptions of these objects to guide him.

It must have been marvelous to be the first person to see the surface of the Moon, the satellites of Jupiter, and the peculiar shape of Saturn with its not-quite-resolved rings. I can only begin to imagine what he must have felt, likening it to the exhilaration I feel when I spot an object that is new to me.

This personal discovery is what drew me to astronomy in the first place. Astronomical objects look different from their pictures in books. I like looking at the originals and wonder what Galileo could see with his inaugural views of the Moon and planets.

My observing experience is with modern telescopes that are large by Galileo's standard. To learn for myself what Galileo could see and what it must have been like to look through his telescope for the first time, I decided to build a replica of the better of his two telescopes.

His telescope had an aperture of 16 millimeters and a focal length of 960 mm, for an f/ratio of 60. The so-called Galilean eyepiece uses a diverging lens, which has a fixed focus and a magnification of 20x. My replica uses eyeglass lenses from a local optical shop.

The scope provides a surprisingly good image with right-side-up orientation, no detectable spherical aberration, and no visible chromatic aberration. A halo appears around Venus because the lenses do not have coatings. The halo might have appeared worse in Galileo's scope because he used different glass, but no colors disturb the image. The field of view is a mere 9 arcminutes in diameter, which makes it an artistic performance to find a given star.

I did not expect that it would be difficult to see Jupiter's moons with this scope. The moons appear as faint "stars" with noticeable disks of low surface brightness in the halo of Jupiter. Saturn appears small but with an obvious oval shape, or a circle with two large ears at its sides, just as Galileo reported. Two dark spots in the "ears" hint at the separation between the planet and its rings. It hardly appears much better in modern binoculars or finderscopes.

The Moon is striking compared with a naked-eye view. You can see only 1/3 of the Moon's diameter in the field at a time. But the actual field of vision is about one degree, which means that by moving your eye you can scan twice the diameter of the Full Moon with the telescope fixed.

As part of my quest to reproduce Galileo's observing adventure, I tried drawing the Moon's surface. I could then compare my drawings to Galileo's. This was a different and challenging experience for me because I'm not an artist.

After I finish a drawing, I sometimes take out a lunar atlas and compare the photograph of the lunar surface with what I've drawn. I find it interesting to see what my brain decided was of "special interest" and what seemed negligible.

Highland areas with their many small craters turned out to be more difficult because of the low resolution of the scope. I was surprised how much my sketches automatically became like those of Galileo.

In this era of large telescopes, multicoated optics, and extra-wide-field eyepieces, give some thought to observing with a telescope like Galileo's. My replica of Galileo's telescope provided a lot of insight into and feeling for the historical development of telescopic astronomy. And it also enriched my life as I discovered for myself what Galileo must have seen when he turned the first telescope to the heavens. ☐

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MEADE APOCHROMAT ED REFRACTORS

6" f/9 Apochromat Only $3995

Meade 6" f/9 Model 152ED Refractor shown with #1697 Computer.

See the Meade ad in this magazine for full specifications and product descriptions. ED = Extremely low dispersion glass which yields color-free virtually perfect images. PPEC = Permanent Periodic Error Correction "Smart Drive."

Model 102 ED 4" f/9 Apochromat & mount (add $105 P&S)	**$1995**
Model 127 ED 5" f/9 Apochromat & mount (add $125 P&S)	**$2495**
Model 152 ED 6" f/9 Apochromat & mount (add $185 P&S)	**$3995**
Model 178 ED 7" f/9 Apochromat & mount (add $215 P&S)	**$4995**

Medium format adapters ..... Mamiya 645, **$98;** Pentax 6X7, **$98**

DRIVE SYSTEMS

#1664 Electronic Drive with PPEC and 2X, 32X slewing system, dual-axis controller	**$375**
#1697 Computer Drive, 747 object computer memory, automatic slewing to desired object	**$695**

8,000 Object CNGC Library .. **$99** Polar alignment finder .. **$99**

OPTICAL TUBE ASSEMBLIES (OTA)

Model 102 ED/OTA 4" f/9 OTA only (add $55 P&S)	**$1075**
Model 127 ED/APO-OTA 5" f/9 OTA only (add $60 P&S)	**$1595**
Model 152 ED/APO-OTA 6" f/9 OTA only (add $70 P&S)	**$2295**
Model 178 ED/APO-OTA 7" f/9 OTA only (add $90 P&S)	**$2995**

Cradle ring assem. 4" (4½" OD tube) **$145;** 5" (5½" OD tube) **$159**
Cradle ring assem. 6" (7" OD tube) **$189;** 7" (8" OD tube) **$240**

EQUATORIAL MOUNTS

LXD 600 mount and standard field tripod (add $50 P&S)	**$1050**
LXD 700 mount and giant field tripod (add $125 P&S)	**$1995**

NOTE: Add the indicated packing and shipping (P&S) costs to each telescope for insured UPS shipment to your door.

MEADE SERIES 4000

"Best Overall Performance"*

6.4, 9.4, 12.4, 15, 20, 26mm Plossl	**$88**
32mm, 40mm Super Plossl	**$110**
56mm Super Plossl (2")	**$230**
13.8mm Super Wide Angle	**$140**
18mm Super Wide Angle	**$150**
24.5mm Super Wide Angle	**$170**
32mm Super Wide Angle (2")	**$240**
40mm Super Wide Angle (2")	**$299**
4.7mm Ultra Wide Angle	**$155**
6.7mm Ultra Wide Angle	**$188**
8.8mm Ultra Wide Angle (1¼/2")	**$230**
14mm Ultra Wide Angle (1¼/2")	**$270**

Shipping charges of 1-2% are extra.

**Plossl test, "SKY & TELESCOPE," p490-492, May 1988*

MEADE LX100 & LX200 SCHMIDT-CASSEGRAINS

8" LX200 $2195

NEW Meade 8" LX200 Telescopes

See the Meade ad in this magazine for full specifications & details. **LX100 Drive,** 2X, 32X speed control with PPEC (Permanent Periodic Error Correction "Smart Drive") & dual-axis hand controller. **LX200 Drive,** Full electronic control with PPEC, 747 object computer memory and automatic computer controlled slewing to desired object. *NOTE:* A wedge is **not** needed for visual observing with the LX200 Drive.

8" **LX100** Schmidt-Cassegrain with wedge (add $105 P&S)	**$1795**
8" **LX200** Schmidt-Cassegrain with computer (add $105 P&S)	**$2195**
Wedge for photographing with 8" LX200	**$110**
10" **LX100** Schmidt-Cassegrain w/super wedge (add $145 P&S)	**$2595**
10" **LX200** Schmidt-Cassegrain with computer (add $145 P&S)	**$2495**
Super Wedge for photography with 10" LX200	**$395**
8,000 Object CNGC Library	**$99**

OTHER SCHMIDT-CASSEGRAINS

NEW! **SSC-8**, 8" Schmidt-Cass on LXD-600 mount (add $105 P&S)	**$1395**
NEW! **SSC-10**, 10" Schmidt-Cass on LXD-600 mount (add $125 P&S)	**$1695**
NEW! **SSC-12**, 12" Schmidt Cass on LXD-700 mount (add $195 P&S)	**$3495**
NEW! **SSC-14**, 14" Schmidt-Cass on LXD-700 mount (add $245 P&S)	**$4795**
Meade 2045D 4" f/10 with motor drive (add $40 P&S)	**$599**
Meade 2080B 8" f/10 with tripod, wedge, MCOG (add $85 P&S)	**$1149**
NEW! Model 2120B 10" f/10 w/wedge, tripod, MCOG (add $125)	**$1449**

PHOTOGRAPHY ACCESSORIES

LUMICON Cassegrain EASY-GUIDER f/6 or f/10	**$225**
LUMICON Giant EASY-GUIDER for 10" f/5-f/10 operation	**$395**

MEADE STARFINDERS

8" f/6 $649*

New 8" f/6 Meade Starfinder telescopes

See the Meade ad in this magazine for full descriptions and technical specifications for 6" to 16" Starfinders. These are complete telescope systems with motor drive, mount, finderscope and 25mm (=48X) eyepiece.

6" f/8 **Starfinder 6**(add $50 P&S)	**$569**
8" f/6 **Starfinder 8** (add $60 P&S)	**$649**
10" f/4.5 **Starfinder 10** (add $75 P&S)	**$759**
16" f/4.5 **Starfinder 16** (ship. freight COD)	**$1995**

*All Starfinder telescopes shipped directly from Meade to the purchaser. Please add the indicated shipping charge to the price. LUMICON showroom prices are $96 higher.

ACCESSORIES

LUMICON carries the full line of Meade accessories. See the Meade ad in this magazine for detailed prices and descriptions.

Meade #43 Single axis drive corrector	**$99**
LUMICON DX200 Dual-axis drive cor.	**$249**
Meade 47M Dual-axis drive corrector	**$399**
LUMICON DX2BP Dual-axis drive corrector with built-in battery pack	**$299**

LUMICON® SKY VECTOR™

Higher Performance — Lower Price

LUMICON ACCESSORIES

LUMICON, 2111 Research Dr., #5, Livermore, CA 94550 (510) 447-9570 FAX (510) 447-9589

LOW PRICE—from $399

LUMICON SKY VECTOR FEATURES:

- "GUIDE" mode leads you to object
- Digital right ascension readout to 1 min.
- Digital decl. readout to 10 arc-min.
- 4000 pulse (0.09° accuracy) encoders
- Polar alignment ***not required!***
- Motor drive ***not required!***
- Just sight two stars to align!
- Works **equally well** for alt-azimuth telescopes like Coulter Odyssey and equatorial mounts like C-8, Meade 2080.
- **No need** to enter latitude, longitude, etc.

SKY VECTOR I™ $399

NEW! With over 220 object memory including the 110 Messier and 58 best NGC objects.

SKY VECTOR II™ $499

IMPROVED — Planets, Over 3,700 Objects! With size, magnitude and full visual description.

NGC SKY VECTOR™ $699

IMPROVED!—5500 Additions / Corrections

NGC-Sky Vector™
OFF ON
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MODE
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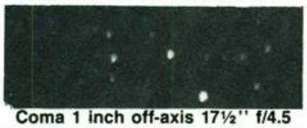
UP
DOWN
LUMICON®

Improved NGC SKY VECTOR with over 12,000 object memory including the planets, complete, corrected RNGC catalogue, IC catalogue, P&K planetary catalogue, & much more!

Specify Telescope Type: Meade 2045, 2080, 2120, C-8, C-11, Odyssey 8, 10, 13, 17½, Alt-Azimuth.

Ultima 8, 11 .. **add $25**, C-14 .. **add $75**

COMA CORRECTOR



Coma 1 inch off-axis 17½" f/4.5

Same field with LUMICON coma corrector; smaller, more numerous stars.

This computer-designed LUMICON 2" lens reduces coma and flattens the field for both viewing and photography. **It threads into LUMICON 2" EASY-GUIDERS for effortless installation.** This zero power lens does not change image scale nor shift focus, and all lens surfaces are multi-coated for highest efficiency. Clear aperture = 1.8".

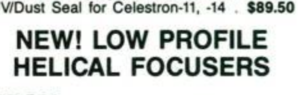
LUMICON 48mm Coma Corrector/Field Flattener Lens	**$285.00**
LUMICON 2" EASY-GUIDER	**$169.50**
2" EASY-GUIDER (Mamiya 645)	**$199.50**
2" Adapter for Pentax 6x7	**$129.00**
2" Adapter for Hasselblad	**$229.00**
2" Adapter for Bronica SQ-A	**$175.00**
2" Extension for viewing	**$26.00**

2" DELUXE BARLOW

1.8x Multiplier Lens (2" Barlow)

LUMICON 1.8x Multiplier Lens (2" Barlow) **$235.00**

LARGE UV/DUST SEAL



Protect the optics of your 8-14" Schmidt-Cassegrain with a UV/Dust Seal. Simply thread it onto the rear cell, then attach all normal accessories. The large size fits Meade 2120, Celestron-11 and -14 & has a high quality multi coated (removable) 72mm UV filter.

Deep-Sky Filter/Dust Seal for C-8, 2080	**$119.50**
UV/Dust Deal for Celestron C-8	**$39.00**
UV/Dust Seal for Meade 2080, 2045	**$39.00**
UV/Dust Seal (large) for Meade 2120	**$89.50**
UV/Dust Seal for Celestron-11, -14	**$89.50**

NEW! LOW PROFILE HELICAL FOCUSERS

FROM $59.50

LUMICON® LOW PROFILE FOCUSERS

LUMICON now offers 3 different low-profile helical focusers. They stand only 1¼-1½" above the telescope tube. Use the 1¼" or 2" versions for viewing. Use the 2" non-rotating focuser for convenient photography with the LUMICON 2" EASY-GUIDER™.

Select your desired base-plate shape! Flat, 7" OD, 9½" OD, 12½" OD, 16" OD, 21" OD.

LUMICON 1¼" Helical Focuser	**$59.50**
LUMICON 2" Helical Focuser 1½" high	**$65.00**
LUMICON Non-rotating Helical Focuser	**$129.00**
2" rack & pinion focuser, only 2" high	**$139.00**
3 handles for non-rotating focuser	**$12.95**
2"/1¼" adapter w/48mm filter threads	**$20.00**
2" LUMICON EASY-GUIDER	**$169.50**

LUMICON 50mm, 80mm SUPER-FINDER™

Visual Astronomers prefer the LUMICON 80mm SUPER-FINDER™, since hundreds of deep-sky objects, including most Messier objects, are visible directly. SUPER-FINDERS also make nice small portable telescopes. 80mm aperture, F=300mm coated achromat or 50mm, F=200mm coated achromat. Eyepieces and/or star diagonal are extra.

1¼" 50mm Finderscope **$59.50**, right-angle	**$59.50**
1¼" straight-thru 80mm SUPER-FINDER	**$169**
1¼" right-angle 80mm SUPER-FINDER	**$179.50**
1¼" right-angle version, w/star diagonal	**$209**
25mm Cross-hair 1¼" eyepiece (12X)	**$39**
Large mounting rings for 80mm Finder	**$55**
1¼" Star Diagonal **$39**, Mounting Brackets,	**$39.50**
1¼" 45° diagonal for correct left-right views	**$52.44**

LOTS OF ADAPTERS

2" adapter for C-8, Meade 2080, etc.	**$26.00**
2" adapter for C-80, C-100 refractor	**$39.50**
2" adapter for C-70, C-80F, C-100F fluorite	**$39.50**
2" adapter for C-6, Comet Catcher, Meade 312	**$30.00**

EXTENSION TUBES

1" long 1¼" OD thread-in extension	**12.00**
2½" long extension (holds 1¼" filters)	**16.00**
4½" long extension for 1¼" eyepieces	**$25.00**
3" long extension for 2" eyepieces*	**$26.00**
2" long extension for 2" eyepieces*	**$26.00**

VIEWING ADAPTERS

2"/1¼" reducing bushing,threaded 48mm*	**$20.00**
2"/T-thread adapter, threaded 48mm*	**$25.00**
T-thread/1¼" adapter	**$25.00**
F/10 2" or 1¼" eyepiece viewing adapter for Giant Easy-Guider	**$39.50**
Low profile star diagonal eyepiece holder	**$16.00**
Meade 2" Diagonal/Giant Easy-Guider	**$39.50**

**Threaded to hold 48mm filters.*

Meade & Celestron
LUMICON Carries a full line of telescopes & accessories. Fast Delivery, competitive prices.

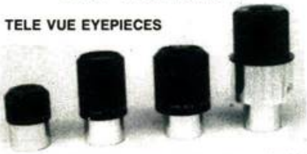
LUMICON FOR HIGH PERFORMANCE

ASTROPHOTO OF THE MONTH

Galaxy NGC 4631 and companion NGC 4627 in Canes Venatici. 60 minute photo by Eraldo Guidolin (in Padova, Italy) using an 8" f/10 telescope, a LUMICON Cassegrain Easy-Guider at f/6 and hypered 2415 film. Mr. Guidolin stated, "With your Cassegrain Easy-Guider I have taken hundreds of perfectly guided high quality photographs."

TELE VUE™
USE THE BEST!

TELE VUE EYEPIECES



Genesis 4" f/5 4 element fluorite	**$1595**
Pronto 70mm f/6.4 apochromat w/2" diagonal	**$749**
Pronto 70mm f/6.4 w/Porro prism	**$689**
Complete Equatorial Mount	**$795**
Motor Drive for above mount	**$239**
7.4, 10.4, 13, 17, 21, 26mm Plossl 50°	**$89**
1.8x or 2.5x Tele Vue Barlow Lens	**$89**
2" Giant Barlow - 2x	**$189**
32mm Plossl, widest true field in 1¼"	**$109**
55mm 2" Plossl, widest possible field	**$219**
15mm Wide-Field, 1¼" eyepiece, 65°	**$135**
19mm Wide-Field, 1¼" eyepiece, 65°	**$145**
24mm Wide-Field, "Rich-Field!" 65°	**$169**
32mm Wide-Field, 2" eyepiece, 65°	**$239**
40mm Wide-Field, "Rich-Field!" 65°	**$299**
4.8mm Nagler, 82° field, 1¼" eyepiece	**$149**
7mm Nagler, 1¼" eyepiece, 82° field	**$189**
9mm Nagler, 82° field, 1¼" or 2"	**$219**
13mm Nagler, 82° field, 1¼" or 2"	**$249**
12mm Nagler, Type II, 82°, 1¼"/2"	**$249**
16mm Nagler, Type II, 82°, 1¼"/2"	**$289**
20mm Nagler, Type II, 82°, 2" only	**$340**
1¼" Paracorr Visual Coma Corrector	**$159**
2" Paracorr Visual Coma Corrector	**$249**
NEW! 22mm Panoptic 1¼"/2", 68°	**$249**
NEW! 35mm Panoptic 2", 68° field	**$325**

ADJUSTABLE PIGGYBACK MOUNT

The LUMICON adjustable piggyback mount is ideal for telescopes of 6-16" aperture. It permits **both** vertical and sideways adjustment for optical alignment. Also ideal to mount LUMICON 80mm SUPER-FINDER™, large telephoto lenses and small telescopes up to about 5 lbs.

LUMICON Adjust. Piggyback Mount $59.50
Specify telescope size: 6", 8", 10", 11", 14", 16"

H-ALPHA PASS FILTER

Yields spectacular contrast gains in B&W photograph with telephoto lenses. Yields pinpoint star images. Superb with hypered 2415. For color, use the Minus Violet (MV) Filter.

Specify Lens Size	**H-Alpha**	**(MV)**
46, 48, 49mm	**$49.00**	**$39.00**
52, 55, 58, 62mm	**$59.00**	**$49.00**
67, 72, 77mm	**$69.00**	**$59.00**
82mm	**$79.00**	**N/A**

Hypered 2415 film, 36 exp .. **$10.95, $3/$29**

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FAX (6 PM-9 AM PST) (510) 447-9589
LUMICON Products catalogue FREE
All foreign orders add 8% ($10 minimum)
California residents add 8.25% tax.
Prices subject to change w/o notice.
Hrs: M-F 9 am - 5 pm, Sat. 11 am - 3 pm

NEW! ENHANCED ALUMINUM DIAGONAL MIRRORS BOOST TELESCOPE PERFORMANCE

LUMICON 1.3" & 2.1" enhanced aluminum diagonal mirrors & 1¼" star diagonal.

The new LUMICON diagonal mirrors have a special enhanced aluminum coating with a protective overcoating for long life. Visible reflectivity is 94-96% compared to 86-89% for standard aluminum coated mirrors. The extra 5-10% transmission is like adding up to an inch of aperture! The substrate is fine annealed Pyrex flat to 1/8 wave.

1.32" **$39.50** 1.52" **$45.00** 1.83" **$49.50**
2.14" **$59.50** 2.60" **$75.00** 3.10" **$99.50**

ENHANCED ALUMINUM STAR DIAGONAL

90° star diagonals with 96% reflectivity enhanced aluminum mirrors in a CNC machined black anodized aluminum body. Performance far exceeds prism diagonals.

1¼" (1.32" mirror) **$99.50**
2" (1.83" mirror)(see photo above) .. **$159.00**

LUMICON FILTERS — BEST IN THE WORLD!

"The LUMICON OIII proved to be our favorite... It gave the greatest contrast gain."
ASTRONOMY February 1991

AMAZING OIII FILTER™

Helix Nebula, NGC 7293 in Aquarius. Bright and easy with Lumicon Oxygen-III Filter.

The ultimate in filter performance! The Lumicon Oxygen-III Filter has a contrast twice as high as the high performance Lumicon UHC Filter™. Use the Oxygen-III Filter for observing the very faintest planetary and diffuse emission nebulae. Also gives incredible views of bright nebulae (like M-27, M-17, etc.) from urban locations. Bandpass is 11nm, transmission is 90-96% for both O-III lines at 496nm and 501nm.

SEE THE HORSEHEAD!

Horsehead Nebula in Orion. This faint nebula is seen best with a LUMICON H-Beta Filter. Photo by J. Marling using a Deep-Sky Filter.

"I CAN SEE THE VEIL NEBULA!"

Rich Zepernick saw the Veil Nebula for the very first time with a **LUMICON UHC Filter**. He stated, *"It was actually there! and not just around 52 Cygni, but the whole loop! Words cannot possibly express my feelings. I don't know how I managed without these filters."*
Rich Zepernick, Cresskill, NJ

DEEP-SKY FILTER™
BEST for Astrophotography!

"Stunning is all I can say," says noted astrophotographer Jack Newton. Great for BOTH color and black and white photography.

BEST WIDE-BAND FILTER!

*"Based on our tests we'd recommend a LUMICON Deep-Sky and Oxygen-III as complementary filters. The LUMICON Deep-Sky Filter clearly had the best contrast for **reflection** nebulae."*
Astronomy, Feb. 1991

Premium*
0.96" LUMICON DEEP-SKY Filter threads into most 0.96" eyepieces **$59.50**
1¼" LUMICON DEEP-SKY Filter threads into most 1¼" eyepieces **$79.50**
48mm LUMICON DEEP-SKY Filter (1.7" aperture), threads into most 2" eyepieces. Also fits LUMICON EASY-GUIDERS **$119.50**
2" LUMICON DEEP-SKY Filter (1.5" aperture), threads into most 2" eyepieces. Also has male & female camera T-threads for prime focus photography **$119.50**
72mm LUMICON Giant DEEP-SKY Filter (62, 67, 77mm adapter, $8) **$299.50**
2" Rear Cell Filter, fits SCT's .... Deep-Sky, **$119.50** UHC, O-III, H-Beta, **$199.50**
1¼" LUMICON UHC Filter threads into most 1¼" eyepieces **$99.50**
48mm LUMICON UHC Filter (1.75" aperture) fits most 2" eyepieces **$199.50**
Set of both premium **DEEP-SKY** and **UHC Filters** (Save 11%) ... 1¼" **$159.50**; 48mm **$279.50**
LUMICON H-BETA Line Filter (9mm bandpass at 486nm). For the California Nebula, Horsehead Nebula, and other extremely faint nebulae. **1¼"** .... **$99.50, 48mm** **$199.50**
Oxygen-III Filter for very faint planetary and diffuse nebulae, 11nm bandpass at 496nm and 501nm O-III lines .... **1¼" $99.50, 48mm $199.50**
Telephoto lens adapter for 2" or 48mm filter. Select 46, 49, 52, 55, 58mm **$6.95**
Universal adapter for 1¼" filters. Adapts the 1¼" filters to any 1¼" eyepiece **$16.00**
Universal adapter for 48mm or 2" filters. Allows use of any 1¼" eyepiece **$20.00**

**Premium filters are currently the best in the world. All Lumicon filters include individually measured transmission data.*

DEEP-SKY ASTROPHOTOGRAPHY

SR-V 3200 NEW FILM

FILM HYPERSENSITIZATION KITS†

LUMICON HYPER-KITS™ yield 3-15x film speed gain in long exposures. They are safe & simple to use. Easy HYPER-KIT includes a chamber with all controls and fittings, thermometer, a refillable cylinder of non-flammable forming gas & hand-operated vacuum pump.

U.S. Patent 4,473,636

MAKE YOUR OWN HYPERED FILM

MODEL 300 HYPER-KIT sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds **$325**

MODEL 600 HYPER-KIT (See photo) Like the Model 300, but also sensitizes 120/220 larger format film and small glass plates **$395**

MODEL 1200 HYPER-KIT is for 4X5" plates and film up to 5X7". Has 2 gas cylinders and includes temperature controller ... **$595**

Temperature controller for any HYPER-KIT **$65**

Electric Vacuum Pump, Model R-10 **$325**

GUIDE OFF-AXIS FOR LOVELY ASTROPHOTOS

All **LUMICON EASY-GUIDER™** off-axis guiders† have both radial and 360° rotational adjustments for 5X easier guide-star selection, use 48mm filters, 360° camera rotation, large prisms for bright guide-stars.
Specify Camera and Telescope type.
U.S. Patent 4,448,500

NEWTONIAN EASY-GUIDER™

Full aperture. Installs in seconds. Specify 2" or 1¼".

NEWTONIAN EASY-GUIDER **$169.50**
3X Relay Diagonal (see photo) **$89.50**
Illuminated reticle eyepiece system .. **$99.50**
Guider for Hasselblad **$350,** Mamiya 645 **$199**
Pentax 6X7 **add $119;** Pentax 645 **add $139**

CASSEGRAIN EASY-GUIDER™

For C-8, Meade 2080, Cynamax-8. Includes 50mm achromatic lens for f/5.8 operation—3X shorter exposures! **Superb rich field viewing, too!**

CASSEGRAIN EASY-GUIDER **$225.00**
Adapter for Hasselblad **$198,** Mamiya 645 **$98**
Pentax 6X7 **add $119;** Pentax 645 **add $139**

GIANT EASY-GUIDER™

For Celestron-11, C-14, and the 10" Meade 2120. Includes 80mm clear aperture achromatic lens for edge-to-edge illumination & pin-point star images. F-ratio adjustable f/4-f/11. **Also yields unmatched Rich-Field viewing.**

GIANT EASY-GUIDER **$395.00**
48mm DEEP-SKY Filter ordered with any EASY-GUIDER (SAVE $20) ..... **add $99.95**
Adapter for Hasselblad **$229,** Mamiya 645**$129**
Pentax 6X7 **add $129;** Pentax 645 **add $149**

WHAT DO YOU NEED?

1. Illuminated reticle eyepiece **$99.50**
Lumicon 12mm eyepiece system has adjustable LED illumination, dual crosslines, battery pack.

2. Cable release for long exposures .. **$9.95**

3. **LUMICON Digital Drive Corrector** . **$249**
Dual-axis drive corrector is essential for astrophotography and/or field use of your telescope. 30Hz/90Hz variable output controls telescope drive. 60Hz digital reference ±12VDC Declination control output. Both 110VAC and 12VDC input for home or field use. Dec. reverse switch for Newtonians.

Declination motor (state telescope) ... **$109**
Variable dec. speed drive w/built-in 5AH battery **$299**

Kodak
SR1600
Scotch
Scotch
1000

HYPERSENSITIZED FILM

LUMICON Hypersensitized film is essential for good deep-sky astrophotography. Deduct 10% for 3 or more rolls (mixed o.k.).***No C.O.D.s.***

Film Type, 35mm	**Exposures**	**Price**
2415, Ultra-fine B&W, red sens.	36	**$10.95**
SR-G3200, fastest of all, color neg	24	**$13.95**
Kodak Ektar 1000 fast, fine grain	24	**$12.95**
Fuji HG400 fine grain color neg.	12	**$10.95**
3M 1000, fastest slide film	12	**$12.95**
Fujichrome RD100, fine grain slide	24	**$12.95**
D-19 B&W Developer	1 gal.	**$6.95**

STAR PARTY ROUNDUP

If you are taking a trip this year, why not include a visit to one of the growing number of star parties around the continent? For listings of more astronomy events in 1993, please see "Meetings and Events" on page 98 of this issue and in subsequent issues.

APRIL

April 10 / Arkansas
All-Night Star Party, White Rock Mountain. Contact: Astronomical Society of Northwest Arkansas, 2503 Sweetbriar Drive, Fayetteville, AR 72703, Betty Davis, (501) 442-2833.

April 10 / New York
Northeast Astronomy Forum, Rockland Community College, Suffern. Contact: Don Urban, Rockland Astronomy Club, 73 Haring Street, Closter, NJ 07624.

April 16 – 17 / Mississippi
Mid-South Regional Stargaze, Rainwater Observatory, French Camp. Contact: Rainwater Astronomical Association, French Camp Academy, French Camp, MS 39745, James Hill, (601) 547-6970.

April 17 / Arizona
Sentinel Star Party, near Sentinel. Contact: Saguaro Astronomy Club, 19026 N. 34th Drive, Phoenix, AZ 85027, Robert Dahl, (602) 582-5526.

MAY

May 14 / Iowa
Kent Park Star Party, Kent Park, Oxford. Contact: Iowa City Astronomy Club, 1205 Diana St., Iowa City, IA, Don Johnson, (319) 354-3815.

May 15 / California
Annual Star Party, Charmlee State Park. Contact: Santa Monica Amateur Astronomy Club, 1415 Michigan Avenue, Santa Monica, CA 90404, Robert Lozano, (310) 450-1944.

May 17 – 23 / Texas
Texas Star Party, Prude Ranch, near Fort Davis. Hosted by the Southwest Region of the Astronomical League. Contact: TSP Registrar, 1326 Mistywood Lane, Allen, TX 75002.

May 21 / Ohio
Wolf Creek Star Party, South Wolf Creek Park. Contact: Sandusky Valley Amateur Astronomy Club, 650 S. Washington Street, Tiffin, OH 44883, Thomas Fretz, (419) 448-9377. Rain date is May 22.

May 21– 22 / California
Star Party, Joshua Tree National Monument. Contact: Los Angeles Sidewalk Astronomers, 1946 Vendanta Place, Hollywood, CA 90068, Pam Reid (310) 696-8792.

May 21 – 22 / Idaho
Craters Star Gaze, Craters of the Moon National Monument. Contact: Idaho Falls Astronomical Society, 1710 Claremont Lane, Idaho Falls, ID 83404, Jim Ruggiero, (208) 524-6317.

May 21 – 22 / New York
Star Party, Saunder's Park, Glenville. Contact: Albany Area Amateur Astronomers, 1529 Valencia Road, Schenectady, NY 12309, Bob Mulford, (518) 374-8744.

May 21 – 23 / North Carolina
Southern Star, Wildacres Retreat, Little Switzerland. Contact: Charlotte Amateur Astronomers Club, 418 School Circle, Harrisburg, NC 28075, Gayle Riggsbee, (704) 846-3136.

May 22 / Kentucky
Public Star Party, Wyandotte Woods State Recreation Area, Leavenworth. Contact: Louisville Astronomical Society, P.O. Box 20742, Louisville, KY 40250-0742, Charles Allen, (502) 228-3043.

May 22 / Michigan
Astroganza, at the Abrams Planetarium. Contact: Capital Area Astronomy Club, Abrams Planetarium, Michigan State University, East Lansing, MI 48824, David Batch, (517) 332-6381.

May 22 / Virginia
Tidewater Spring Star Party, Portsmouth. Contact: Tidewater Community College Astronomical Society, Physics Dept., State Route 135, Portsmouth, VA 27303, Aubrey Hartman, (804) 484-4354.

May 22 – 24 / New York
Astronomy Weekend '93, Martz Observatory. Contact: Marshal Martz Memorial Astronomical Association, 176 Robin Hill Road, Frewsburg, NY 14738, Tom Bemus, (716) 386-4566.

May 28 – 30 / California
Riverside Telescope Makers Conference, Camp Oakes, Big Bear Lake area. Contact: RTMC, Fox and Stephens, CPA, 9045 Haven Avenue #109, Rancho Cucamonga, CA 91730, (714) 948-2205.

May 29 / Illinois
Family Skywatch, Champaign. Contact: Champaign-Urbana Astronomical Society, 706 Kenwood Road, Champaign, IL 61821, David Leake, (217) 359-6644.

JUNE

June 11 – 12 / Arizona
Astronomy Festival, Red Rock State Park. Contact: Verde Valley Astronomy Club, 1101 Zalesky Road, Sedona, AZ 86326, Prof. Nidley, (602) 634-7332.

June 11 – 12 / Ohio
Apollo Rendezvous and Telescope Fair, Dayton Museum of Natural History. Contact: Miami Valley Astronomical Society, 5932 Culzean Drive #706, Dayton, OH 45426, Ian Dumbauld, (513) 837-4600.

June 11 – 13 / Nebraska
Convention of the Midstates Region of the Astronomical League, Nebraska Wesleyan University, Lincoln. Contact: Richard Johnson, 1860 Pawnee Street, Lincoln, NE 68502.

June 12 – 19 / Arizona
Grand Canyon Star Party, Grand Canyon National Park. Contact: Dean Ketelson, c/o Tucson Amateur Astronomy Association, P.O. Box 41254, Tucson, AZ 85717.

June 18 / New York
Stairway to Heaven, Ward Pound Ridge Reservation, Cross River. Contact: Westchester Amateur Astronomers, P.O. Box 111, Chappaqua, NY 10514, Robert Davidson, (914) 238-4533.

June 18 – 20 / Minnesota
First Annual Star Party, Sola Fide Observatory, Austin. Contact: Cedar River Astronomy Club, 407 15th Street SE, Austin, MN 55912, Keith Snyder, (507) 433-1903.

June 18 – 20 / Pennsylvania
Mason-Dixon Star Party, Spring Valley County Park, Glen Rock. Contact: York County Parks Astronomical Society, 400 Mundis Race Road, York, PA 17402, Jeri Jones, (717) 225-3744.

June 18 – 20 / Wisconsin
Wisconsin Observers' Weekend, Hartman Creek State Park, Waupaca. Contact: NEWSTAR, the Northeast Wisconsin Stargazers, 1815 Kienast Avenue, Oshkosh, WI 54901, Don Wyman, (414) 233-3083.

June 19 – 21 / New Jersey
Jersey Star Quest IV, Beemville. Contact: Amateur Astronomers Association of Princeton, P.O. Box 2017, Princeton, NJ 08540, Greg Mauro, (609) 585-9465.

June 26 / Oklahoma
Prairie Star Party, Bartlesville. Contact: Bartlesville Astronomical Society, Route 2, Box 940, Bartlesville, OK 74006, Ken Willcox, (918) 333-1966.

JULY

July 1 – 5 / Nova Scotia
General Assembly of the Royal Astronomical Society of Canada, Halifax. Contact: Halifax Centre of the RASC, 26 Randall Avenue, Apt. 4, Halifax, Nova Scotia, Canada B3M 1E2, David Lane, (902) 420-5633.

July 10 – 15 / California
UNIVERSE '93, a National Astronomy Expo, University of San Diego. Presented by the Astronomical Society of the Pacific and ASTRONOMY magazine. Amateur astronomy product fair and talks July 10 – 11. Contact: Meeting Information, A.S.P., 390 Ashton Ave., San Francisco, CA 94112, (415) 337-1100.

July 16 – 18 / Massachusetts
The Conjunction, Northfield Mountain Environmental Center. Contact: Jack Megas, 311 Surrey Road, Springfield, MA 01118.

July 16 – 17 / Ontario
Gateway to the Universe, Munro Park, Powassan. Contact: North Bay Astronomy Club, 50 Van Horne Crescent, North Bay, Ontario, Canada P1A 3L3, Merlin Clayton, (705) 472-1182.

July 16 - 17 / Washington
Astronomical League Northwest Regional Convention and High-Altitude Star Party, Table Mountain, near Ellensburg. Contact: Thom Jenkins, P.O. Box 8114, Spokane, WA 99203-0114, (509) 838-1381.

July 16 – 18 / Colorado
Annual Star Stare Campout and Star Party, Badger Flats. Contact: Colorado Springs Astronomical Society, P.O. Box 62022, Colorado Springs, CO 80962, Chris Weatherill, (719) 473-3621.

July 16 – 18 / Wyoming
Weekend under the Stars, Fox Park. Contact: Cheyenne Astronomical Society, 6614 North College #G, Cheyenne, WY 82009, Marty Curran, (307) 635-5944.

July 17 / California
Cluster Hunt Star Party, Crystal Falls Park. Contact: Sonora Astronomical Society, 21581 Phoenix Lake Road #4, Sonora, CA 95370, Lance Kearns, (209) 536-0344 (before 8 p.m.)

July 17 / Ohio
OTAA Oberlin Convention, Oberlin College. Contact: Cuyahoga Astronomical Association, P.O. Box 29089, Cleveland, OH 44129, Bill Gerling, (216) 779-9779.

July 23 – 25 / Nova Scotia
Highland Star Party, Cape Breton Highlands National Park. Contact: Cape Breton Astronomical Society, 131 Green Acres Drive, Sydney River, Nova Scotia, Canada B1S 1K5, John Reppa, (902) 562-2772.

July 23 – 25 / Ontario
Naturalist of the Night Weekend, Sleeping Giant Provincial Park, Thunder Bay. Contact: Thunder Bay Centre of the RASC, 135 Hogarth Street, Thunder Bay, Ontario, Canada P7A 7H1, Bob Bishop, (807) 767-5689.

July 29 – 31 / Wisconsin
ALCON '93 National Convention, Sheraton Inn, Madison. National meeting of the Astronomical League. Contact: Madison Astronomical Society, ALCON 93, P.O. Box 14747, Madison, WI 53714-0747.

AUGUST

August 11 – 15 / Alberta
Alberta Star Party, Eagle Lake Campground, south of Strathmore. Contact: Edmonton Centre of the RASC, 9335 - 176 Avenue, Edmonton, Alberta, Canada T5Z 2C4, Sylvia Smith, (403) 456-4614.

August 13 – 14 / Arkansas
Mt. Magazine Star Party, Mt. Magazine. Contact: River Valley Stargazers, P.O. Box 261, Dover, AR 72837, Rex Allen McDaniel, (501) 331-3773.

August 13 – 14 / Oklahoma
Northwest Oklahoma Star Party, Enid. Contact: Northwest Oklahoma Astronomy Club, 1719 Pawnee, Enid, OK 73703, Dan Matthews, (405) 233-5707.

August 13 – 14 / Vermont
Stellafane, near Springfield. Contact: Stellafane, 60 Victoria Road, Sudbury, MA 01776.

August 13 – 15 / Wisconsin
Northwoods Starfest, Hobbs Observatory Center, Beaver Creek Reserve. Contact: Chippewa Falls Astronomical Society, c/o Hobbs Observatory, Route 2, Box 94, Fall Creek, WI 54742, Bob Elliott, (715) 877-2787.

August 14 / California
Annual Star Party, Winchester Canyon Gun Club, Santa Barbara. Contact: Santa Barbara Astronomy Club, P.O. Box 3702, Santa Barbara, CA 93130, Clyde Kirkpatrick, (805) 966-3695.

August 14 / Nebraska
Prairie Astronomy Club Star Party, Hyde Observatory, Holmes Park, Lincoln. Contact: Prairie Astronomy Club, P.O. Box 80553, Lincoln, NE 68501, Lee Thomas, (402) 483-5639.

August 14 / Ohio
Ohio Turnpike Astronomers Association Convention, Mahoning Valley Observatory, Newton Falls. Contact: Mahoning Valley Astronomical Society, 1076 State Route 534, Newton Falls, OH 44444, Mark Baker, (216) 537-3939.

August 18 – 22 / British Columbia
Mount Kobau Star Party, summit of Mount Kobau near Osoyoos. Contact: Peter Kuzel, 4100 25th Avenue, Vernon, BC, Canada V1T 1P4, (604) 545-1226.

August 19 – 22 / Oregon
Oregon Star Party, Ochoco Mountains, 60 miles NE of Bend. Sponsored by Rose City Astronomers of Portland. Contact: Chuck Dethloff, 15111 NW Oakmont Loop, Beaverton, OR 97006, (503) 629-2145.

August 20 and 21 / Indiana
Summer Spectacular Star Party, Lemon Lake County Park, Crown Point. Contact: Calumet Astronomical Society, P.O. Box 851, Griffith, IN 46319, Stephen J. Miller, (219) 845-9174.

August 20 – 22 / Iowa
Eastern Iowa Star Party, Wapsi River Environmental Education Center. Contact: Quad Cities Astronomical Society, P.O. Box 3706, Davenport, IA 52808, William Brown, (309) 786-9622.

August 20 – 22 / Michigan
Southern Michigan Universal Regional Festival of Stargazers (SMURFS), near Clare. Contact: Genesee Astronomical Society, c/o Robert T. Longway Planetarium, E. Kearsley Street, Flint, MI 48503, Richard Walker, (313) 627-9524.

August 20 – 22 / New Brunswick
Nova East '93, Fundy National Park. Contact: Halifax Centre of the RASC, 1747 Summer Street, Halifax, Nova Scotia, Canada B3H 3A6, David Lane, (902) 420-5633 (days).

August 20 – 22 / New York
Syracuse Summer Seminar, Darling Hill Observatory, Vesper. Contact: Syracuse Astronomical Society, Inc., 1115 E. Colvin Street, Syracuse, NY 13210, Joseph Italiano, (315) 475-7032.

August 20 – 22 / Ontario
Starfest '93, Riverplace Campground, Mount Forest. Sponsored by the North York Astronomical Association. Contact: Andreas Gada, 26 Chryessa Avenue, Toronto, Ontario, Canada M6N 4T5.

August 21 / California
Mountain Skies Starwatch, Lake Arrowhead Village. Contact: Mountain Skies Astronomical Society, 28200 Hwy 18 #F240, P.O. Box 1169, Lake Arrowhead, CA 92352, Lorann Parker, (909) 337-4075.

August 21 / Virginia
Tidewater Summer Star Party, Portsmouth. Contact: Tidewater Community College Astronomical Society, Physics Dept., State Route 135, Portsmouth, VA 27303, Aubrey Hartman, (804) 484-4354.

August 28 / Minnesota
Northern Nights, Duluth. Contact: Arrowhead Astronomical Society, c/o Alworth Planetarium, University of Minnesota, Duluth, MN 55812, Glenn Langhorst, (218) 389-6212.

SEPTEMBER

September 10 – 12 / Illinois
Astrofest '93, Shaw-Waw-Nas-See 4H Camp, near Kankakee. Contact: Chicago Astronomical Society, P.O. Box 30287, Chicago, IL 60630-0287, Michael Barrett, (312) 725-5618.

September 17 – 18 / Nevada
7th Annual Dark Sky, Cathedral Gorge State Park. Contact Las Vegas Astronomical Society, G.W. Hotels, 401 South Casino Center Blvd., Las Vegas, NV 89101, (800) 634-6635.

September 17 – 18 / West Virginia
Blackwater Falls Astronomy Weekend, Blackwater Falls State Park, near Davis. Contact: Kanawha Valley Astronomical Society, Sunrise Children's Museum, 746 Myrtle Road, Charleston, WV 25314, Rich Ireland, (304) 344-9620.

September 17 – 19 / Connecticut
Connecticut Star Party, Camp Bobriwka, Colebrook. Contact: Astronomical Society of New Haven, P.O. Box 3005, New Haven, CT 06515, Linda Marks, (203) 874-4816.

September 18 / North Carolina
Blue Ridge Parkway Regional Stargaze (Part 1), Julian Price Park, 4.5 miles south of Blowing Rock. Part 2 event held at same site October 16. Contact: Catawba Valley Astronomy Club, Route 3, Box 472, Granite Falls, NC 28630, Greg Kirby, (704) 396-7656.

September 18 / Ohio
Ohio Turnpike Astronomers Association Convention, Strawberry Mountain, Birmingham. Contact: Black River Astronomical Society, 1631 Maple Drive, Lorain, OH 44052, Michael Harkey, (216) 288-8556.

September 25 / Indiana
Northern Indiana Astronomical Groups (NIAG) Fest '93, Camp Crossley, Warsaw. Contact: Michiana Astronomical Society, P.O. Box 262, South Bend, IN 46624, Thomas Nowicki, (219) 255-9492.

September or October (TBA) / Georgia
Georgia Star Party, Hard Labor Creek Observatory. Contact: Astronomical Society of the Atlantic, c/o Center for High Angular Resolution Astronomy, Georgia State University, Atlanta, GA 30303-3083, Ingrid Tanghe, (404) 873-1453.

OCTOBER

October 7 – 9 / Kentucky
4th Annual Twin Lakes Star Party, Golden Pond Observatory. Contact: West Kentucky Amateur Astronomy Club, Jim Boren, (615) 232-6820.

October 7 – 10 / Missouri
3rd Annual Great Plains Star Party, Kansas Flint Hills, 75 miles SW of Kansas City. Contact: Bob Nederman, 9200 Westbrooke Drive, Overland Park, MO 66214.

October 8 – 9 / Ohio
Hidden Hollow/Greatcon 93, Warren Rupp Observatory, Mansfield. Contact: Richland Astronomical Society, P.O. Box 1118, Mansfield, OH 44901-9998, Keith Moore, (419) 468-3542.

October 12 – 17 / Texas
Okie-Tex Star Party, Prude Ranch, near Fort Davis. Contact: Oklahoma City Astronomy Club, P.O. Box 21221, Oklahoma City, OK 73156, Clive or Beryl Cadle, (405) 789-3742.

October 14 – 17 / Florida
Chiefland Starfest, Chiefland. Contact: Astro Scopers, Route #1, Box 302-C, Chiefland, FL 32626, Sparky Talios, (904) 493-4359.

October 15 – 16 / Arizona
All-Arizona Star Party, 15 miles south of Arizona City. Contact: East Valley Astronomy Club, 1836 N. Stapley Drive #100, Mesa, AZ 85203, Ted Heckens, (602) 827-1524.

October 15 – 16 / New York
Kopernik Astronomy Fest, Kopernik Space Education Center, Vestal. Contact: Kopernik Astronomical Society, 698 Underwood Road, NY 13850, Jay Edwards, (607) 748-3685.

October 15 – 17 / Mississippi
Deep South Regional Stargaze, Percy Quinn State Park. Contact: Jackson Astronomical Association, 6207 Winthrop Circle, Jackson, MS 39206-2323, Walter Rebmann, (601) 982-2317.

October 15 – 17 / New York
15th Annual Astronomy Jamboree, Custer Institute, Southold. Contact: Custer Institute Observatory, Box 1204, Main Bayview Road, Southold, NY 11971, Barbara Lebkuecher, (516) 722-3850.

October 16 / Virginia
Tidewater Autumn Star Party, Portsmouth. Contact: Tidewater Community College Astronomical Society, Physics Dept., State Route 135, Portsmouth, VA 27303, Aubrey Hartman, (804) 484-4354. □

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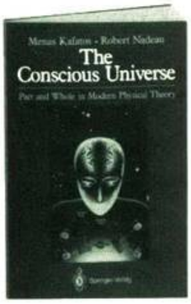
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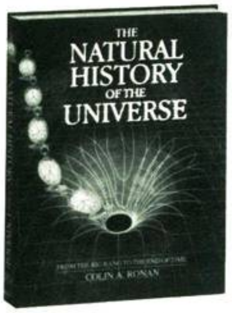
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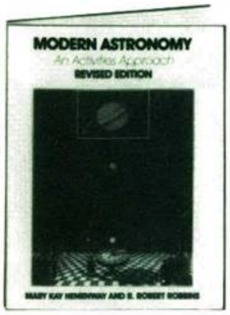
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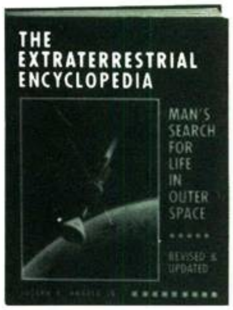
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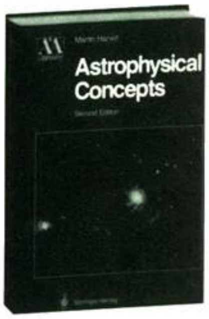
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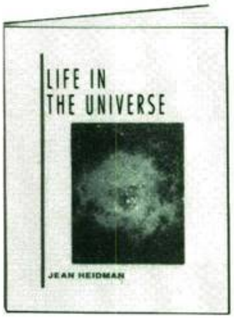
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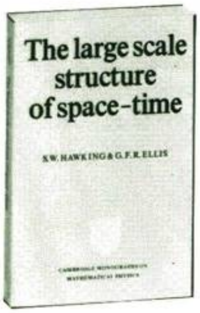
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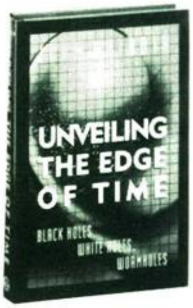
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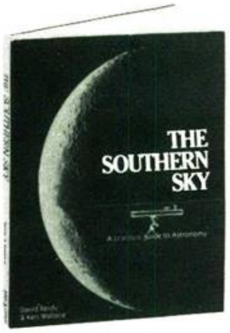
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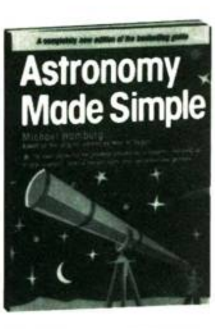
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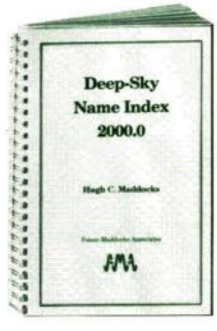
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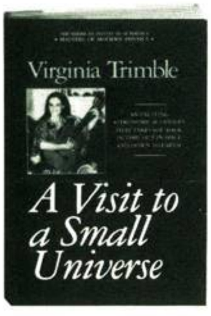
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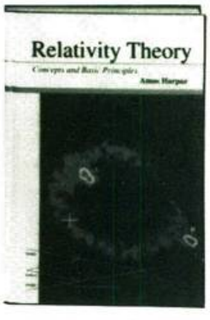
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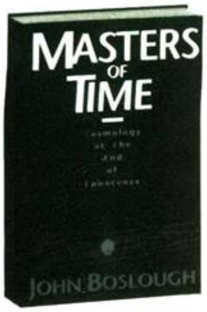
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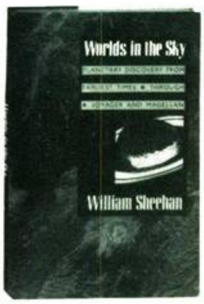
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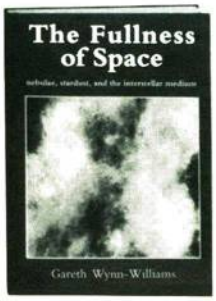
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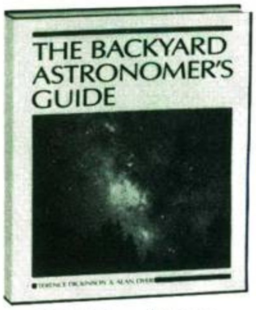
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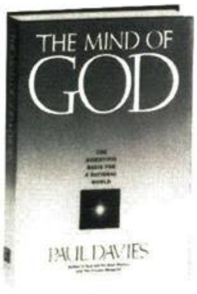
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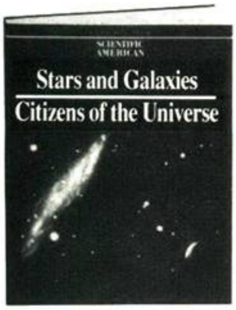
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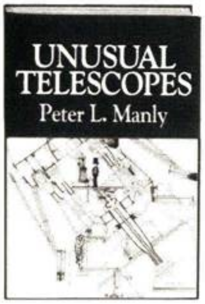
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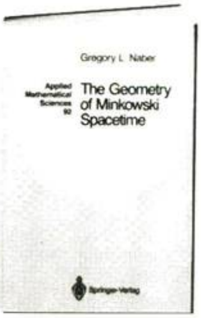
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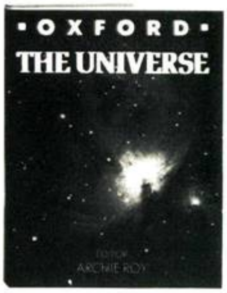
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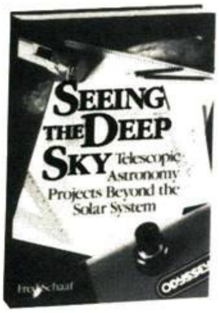
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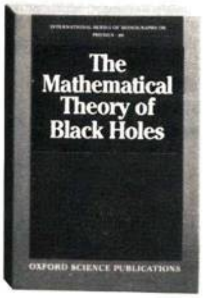
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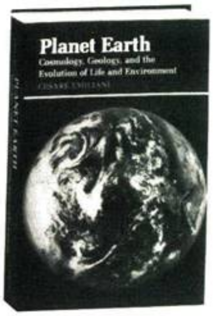
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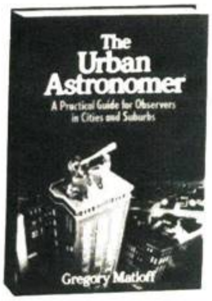
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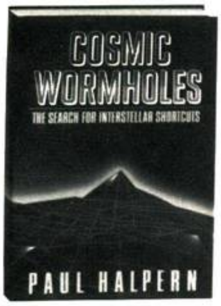
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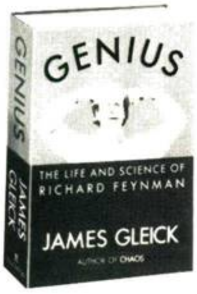
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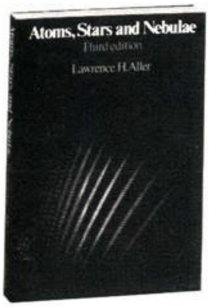
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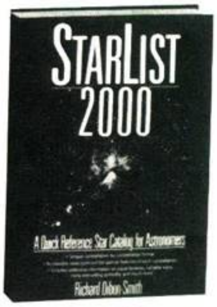
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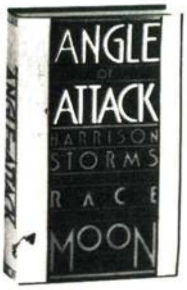
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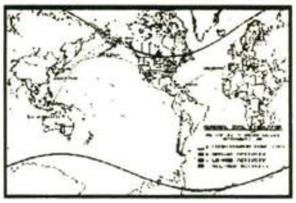
WANTED — Prison inmate wishes to correspond with anyone interested in science fiction, space exploration, and Moon colonization. Contact James T. Dixon, #098970-N-3, Polk Correctional Institution, 3876 Evans Rd.–Box 50, Polk City, FL 33868-9213.

WANTED — Information about contests for amateur makers of science-fiction films and films in general. Contact Steve Sutton, P.O. Box 842, Springfield, GA 31329.

WANTED — Twenty-five-year-old amateur astronomer seeks correspondence with anyone interested in astronomy. Other interests include astrophysics, particle physics, computers, and *Hitchhiker's Guide to the Galaxy*. Contact Kevin Strider, 123 Abbey Rd., Abbey Hulton, Stoke-on-Trent ST2 8AZ, ENGLAND.

FOR SALE — Criterion 6" Newtonian reflector. Includes heavy-duty equatorial mount and eyepieces, but no spotting scope. $250. Contact Roy L. Templeton, 1130 Avondale Dr., Seneca, SC 29678. Phone (803) 882-6059.

WANTED — *Scientific American* issues prior to 1920. Also books or photos by James E. Keeler (Lick Observatory) or Isaac Roberts. Contact Dennis P. Predzial, Box 23, Chadds Ford, PA 19317.



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COBE CONFIRMS BIG BANG (AGAIN!)

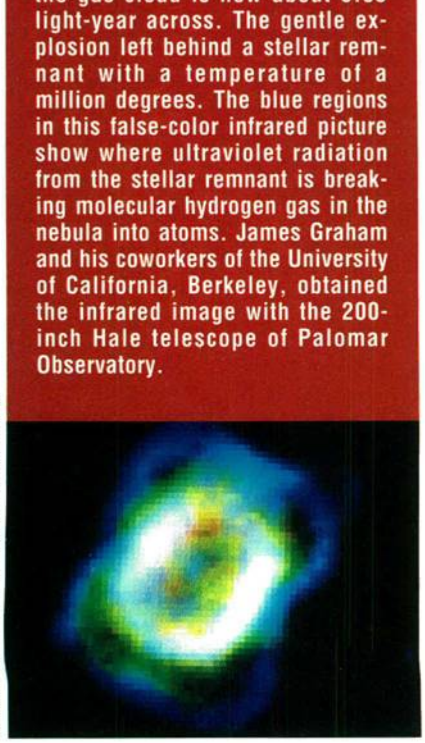
The temperature of the cosmic background radiation precisely matches that predicted by the big bang theory. That's the conclusion drawn by astronomers working with data returned by the Far Infrared Absolute Spectrophotometer (FIRAS) onboard the Cosmic Background Explorer (COBE) satellite. COBE Project Scientist John Mather of NASA's Goddard Space Flight Center announced the findings at the January meeting of the American Astronomical Society held in Phoenix, Arizona.

The astronomers found that the temperature of the background radiation is 2.726 kelvins (2.726° Celsius above absolute zero) with an uncertainty of 0.01 kelvin and that it remains the same at every wavelength they could measure between 0.5 and 5 millimeters. The measurements match theory to within 0.03 percent, a limit some 30 times better than the first COBE results announced in 1990 and 1,000 times better than the best pre-COBE data.

The data also tell astronomers that 99.97 percent of the radiant energy of the universe was released in the first year after the big bang. All theories that attempt to explain the large scale structure seen in the universe must conform to these constraints. (See "COBE's Big Bang," August 1992.) That rules out many theories postulating lots of "little bangs" — large releases of energy from such things as black holes, exploding supermassive stars, or the decay of unstable elementary particles.

HOT GAS GLOWS MAGENTA in this false-color composite image of the NGC 2300 galaxy group. A visible light image of the three galaxies in the group, located 150 million light-years away in Cepheus, was combined with a ROSAT image showing the X-ray emission (magenta) from a huge cloud of hot gas in the group. The cloud glows at a temperature of 10 million kelvins, spans 1.3 million light-years, and has 500 billion times the mass of the Sun. To contain a cloud of this mass, however, the group must contain at least a dozen times as much dark matter as visible matter. The research team who performed the ROSAT observations was led by John Mulchaey of the Space Telescope Science Institute.

NASA



A DYING STAR EJECTED its outer layers about 600 years ago and formed this young planetary nebula. The nebula, NGC 7027, lies in the constellation Cygnus. Expanding at 50,000 kilometers per hour, the gas cloud is now about 0.03 light-year across. The gentle explosion left behind a stellar remnant with a temperature of a million degrees. The blue regions in this false-color infrared picture show where ultraviolet radiation from the stellar remnant is breaking molecular hydrogen gas in the nebula into atoms. James Graham and his coworkers of the University of California, Berkeley, obtained the infrared image with the 200-inch Hale telescope of Palomar Observatory.

James R. Graham, University of California, Berkeley

HOW WAS THE MILKY WAY GALAXY BORN?

The central and outer regions of our Galaxy most likely formed in different ways. The center probably resulted from the collapse of a single massive clump of matter, while the outside may have come from the captured remnants of several smaller objects. Sidney van den Bergh of the Dominion Astrophysical Observatory in Victoria, British Columbia, presented this new scenario at the January 1993 meeting of the American Astronomical Society in Phoenix, Arizona.

In 1962 Olin Eggen, now at the National Optical Astronomy Observatories, Allan Sandage of the Carnegie Observatories, and Donald Lynden-Bell of Cambridge University hypothesized that the Milky Way formed when a single huge protogalaxy having a mass hundreds of billions of times that of the Sun collapsed. Then in 1978 Leonard Searle, now at the Carnegie Observatories and Robert Zinn, now at Yale, proposed that the Galaxy formed not through collapsing but through the gradual accumulation of thousands of much smaller clumps of matter, each only tens of millions of times as massive as the Sun. The debate over which idea is correct has raged ever since.

Van den Bergh notes that many of the globular clusters in the outer part of the galactic halo formed more recently than those closer to the center of the Galaxy. And many of these younger clusters have highly elongated orbits or move retrograde about the Galaxy's center — opposite the direction of most galactic stars.

In 1975 van den Bergh showed that globular clusters surrounding massive galaxies have much higher abundances of what astronomers call "metals" — those elements heavier than helium — than those surrounding low-mass galaxies. The metal content of the Milky Way globulars implies they formed in objects comparable to or slightly larger than the Large Magellanic Cloud, which weighs in at roughly 10 billion solar masses.

Van den Bergh concludes that the Milky Way Galaxy formed by a hybrid process. Most of the central region probably formed when a huge protogalactic mass collapsed. The outer regions consist mainly of the remnants of a small number of gaseous objects, each weighing a few tens of billions of solar masses, that merged with the protogalactic core.

STARSPOTS FOUND ON PROXIMA CENTAURI

Although reddish Proxima Centauri is our nearest star, it hasn't been well observed because it glows faintly at magnitude 11. But new observations of the star made with the Hubble Space Telescope are changing all that. George Benedict of the University of Texas has found spots on the star.

While searching for planets around Proxima, Benedict noticed that the star changes brightness by about 2 percent over a 41-day period. The period is close to the rotation period expected for a star of Proxima's size, so Benedict believes that he saw a region of different temperature rotate in and out of our view. Like describing a zebra's black-and-white stripes, it's hard to know if the region is a dark spot surrounded by the star's brighter surface or if it's a bright region surrounded by the star's darker surface. He also saw some flares, rapid changes in the star's brightness, lasting about 100 seconds.

Benedict's search to see if Proxima has planetary companions will continue for another year. But even if he comes up empty-handed, astronomers have already learned something important about the surface of the star closest to the Sun.

SIZING UP NOVA CYGNI

Nova Cygni 1992 burst forth around February 20, 1992. Just eight days later, Andreas Quirrenbach of the Universities Space Research Association in Washington, D.C., provided the first measurement ever of a nova's expanding shell shortly after the outburst. He measured the apparent size of the expanding envelope to be 0.0051 arcsecond (less than a tenth of a light-day) across. This diameter measurement is crucial because it allows astronomers to fix the distance to the nova.

Separate measurements showed that the shell expanded then at a speed of about 1,000 kilometers per second. This information about the speed and diameter of the shell allows Quirrenbach and other astronomers in the same research group to calculate the nova's distance to be around 8,500 light-years. And the distance enables astronomers to determine the absolute brightness of the nova, which is important for understanding how the star exploded.

Quirrenbach used the MARK III optical interferometer located at Mount Wilson Observatory, north of Pasadena, California. The interferometer uses two small telescopes that work together to mimic the resolving ability of a much

Amateur News

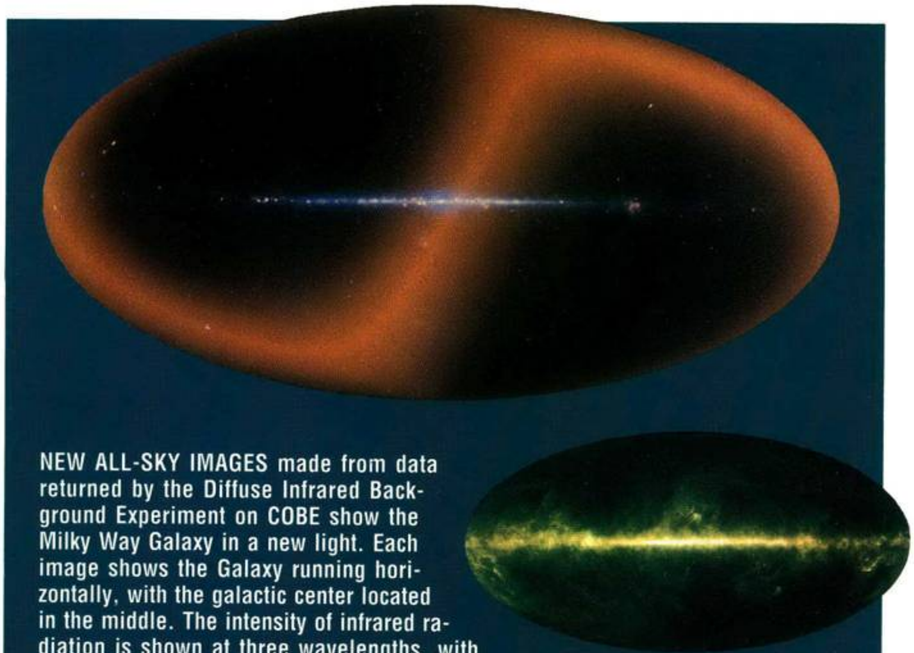
ASTRONOMY DAY TURNS 20

National Astronomy Day is celebrating a milestone anniversary. Twenty years ago several clubs in California had the idea of declaring an official Astronomy Day in their communities. The added publicity this provided helped the groups attract more people to their public events.

Since then, the idea has expanded across the continent. Now hundreds of astronomy clubs and planetariums stage special events for the public on Astronomy Day. Star parties, shopping mall displays, observatory open houses, public lectures — you'll find them all on Astronomy Day.

This year the thirteen cosponsors of Astronomy Day, organizations such as the Astronomical League and Astronomical Society of the Pacific, have set aside two successive Saturdays for activities. Groups will be hosting events on April 24 or May 1, or in some cases all week long during an ambitious Astronomy Week program.

To find out what activities are happening in your area, check the directory in this issue for the astronomy club or planetarium in your home town. Give them a call and see what they have planned.



NEW ALL-SKY IMAGES made from data returned by the Diffuse Infrared Background Experiment on COBE show the Milky Way Galaxy in a new light. Each image shows the Galaxy running horizontally, with the galactic center located in the middle. The intensity of infrared radiation is shown at three wavelengths, with blue representing the shortest wavelength, green the intermediate wavelength, and red the longest wavelength.

NASA/GSFC

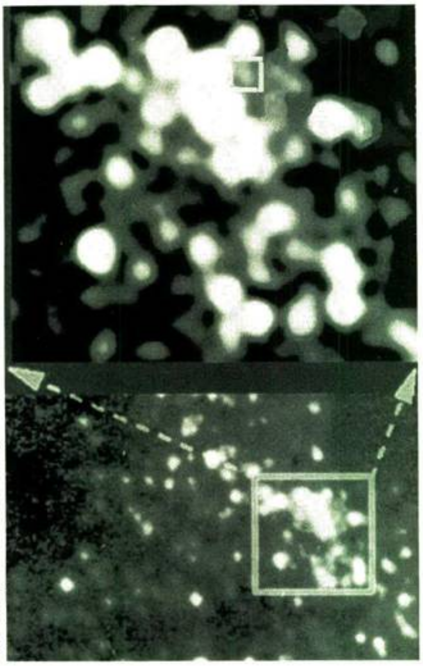
The 4.9-, 12-, and 25-micron image (upper) most prominently shows an orange S-shaped curve caused by interplanetary dust in the solar system, though galactic emission from stars and cool interstellar dust also contribute. The 100-, 140-, and 240-micron image (lower) is dominated by thermal emission from cold interstellar dust (at a temperature of about 20 kelvins, or 20° Celsius above absolute zero). The wispy-looking features are called infrared cirrus. The Orion molecular cloud can be seen below the Galaxy's plane at far right, while the Large and Small Magellanic Clouds appear below the plane and approximately halfway between the center and right edge of the image.

larger telescope. To look at Nova Cygni 1992, he used two telescopes with effective apertures of only 2 inches separated by 66 feet. The measurement of the nova's envelope is just the first of many exciting discoveries expected from the interferometer.

NEW VIEWS OF THE GALACTIC CENTER

Sagittarius A* is a compact radio source at the center of our Galaxy. Astronomers have long thought that a black hole resides in Sgr A* (pronounced "saj A-star"). New evidence from several researchers supports this idea and provides an estimate of the black hole's mass.

Laird Close, Don McCarthy, Fulvio Melia, and Julian Christou of the University of Arizona's Steward Observatory looked at Sgr A* with a new infrared camera that subtracts blurring introduced by Earth's atmosphere. They found a single point source of faint emission coming from Sgr A*. The brightness of the source agrees with the amount of radiation expected to come from a black hole containing a million times the Sun's mass.



Laird Close, Steward Observatory

A MASSIVE BLACK HOLE MAY LURK in the center of our Galaxy, marked by a radio source called Sagittarius A*. Astronomers have discovered faint infrared emission coming from Sgr A* in the amount expected from a black hole containing a million solar masses. The box in the top image is 0.1 light-year across and shows the location of Sgr A* and the infrared source.

Another Steward Observatory group, consisting of Joseph Haller, Marcia Rieke, and George Rieke, provides additional infrared evidence for the black hole. They observed the orbital speeds of red giant stars at distances of 0.2 to 3.4 light-years from Sgr A*. Stars about 0.7 light-year away orbit 100 times faster than do stars around 1.4 light-years away. The motions of the stars imply that a large mass exists in Sgr A*, about 900,000 times the mass of the Sun.

But to stir the controversy surrounding the Galaxy's black hole, another mass estimate suggests that the black hole may contain only 1,000 times the mass of the Sun. Apostolos Mastichiadis and Leonid Ozernoy of NASA's Goddard Space Flight Center say that the low level of X rays and gamma rays from Sgr A* indicates that the mass of the black hole must be much lower than the one million solar masses usually given.

Clearly, much work remains for astronomers regarding the mass of the Sgr A* black hole. Confirmation of Sgr A* as a black hole is crucial to their understanding of how massive black holes form in galaxies. And it plays a key role in learning about the central engines that power quasars and the nuclei of active galaxies. ☐

Space News

SHUTTLE EXPERIMENT REVEALS SUPERNOVA BUBBLE

An experiment on January's flight of the space shuttle Endeavour is providing new evidence that our solar system is located near the edge of a superhot bubble of gas created by a nearby supernova explosion.

The main mission of Endeavour was launching another in the series of Tracking and Data Relay Satellites. But tucked away in the cargo bay was a telescope system called the Diffuse X-ray Spectrometer, or DXS, designed and operated by scientists at the University of Wisconsin-Madison and NASA's Goddard Space Flight Center. During the flight DXS scanned the sky, taking spectra of the low-energy, or soft, X rays coming from interstellar space.

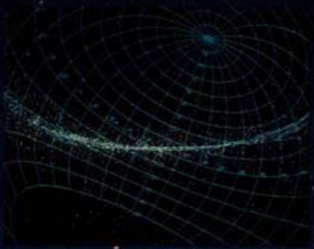
"What we are seeing is like an echo from the past," said Wilton T. Sanders, a UW-Madison astrophysicist and the principal investigator for the DXS project. "For 25 years we've speculated about the origins of these X rays and now this echo is starting to give us some answers."

The theory DXS is confirming states that the soft X rays, observable in all directions from the Earth, come from cavities of superhot ionized gas (including a pocket known to astrophysicists as the Local Bubble) that surround our solar system. The bubble may have been blown into space by recent supernovae and then heated to X-ray-hot temperatures by the blast waves of the supernovae.

Recently, observations from the ROSAT X-ray satellite and the Compton Gamma Ray Observatory (GRO) identified the enigmatic gamma-ray source Geminga as a pulsar — the compact remains of a supernova — thus uncovering a possible source of the Local Bubble. Calculations using GRO data show that Geminga exploded some 300,000 years ago, a time consistent with the reheating of the Local Bubble.

Since the Geminga supernova event, the blast wave from that cataclysmic explosion has coursed through space, creating an expanding pocket of superhot X-ray emitting gas that extends for several hundred light-years with our solar system near its edge. But the pocket of gas created by Geminga, said Sanders, might itself be within another larger bubble created by a far older supernova event. The DXS detectors scanned regions of space away from Geminga and obtained spectra that look substantially different from the spectra of X rays coming from the direction of the newly identified pulsar. "What we may be seeing at Geminga is the creation of a gas bubble within a gas bubble," Sanders said. "The effect of Geminga would be to reheat and, if it exploded near the edge of this region, enlarge the existing cavity in one direction." — *Terry Devitt*

ALTER FOREVER YOUR SENSE OF SPACE AND TIME



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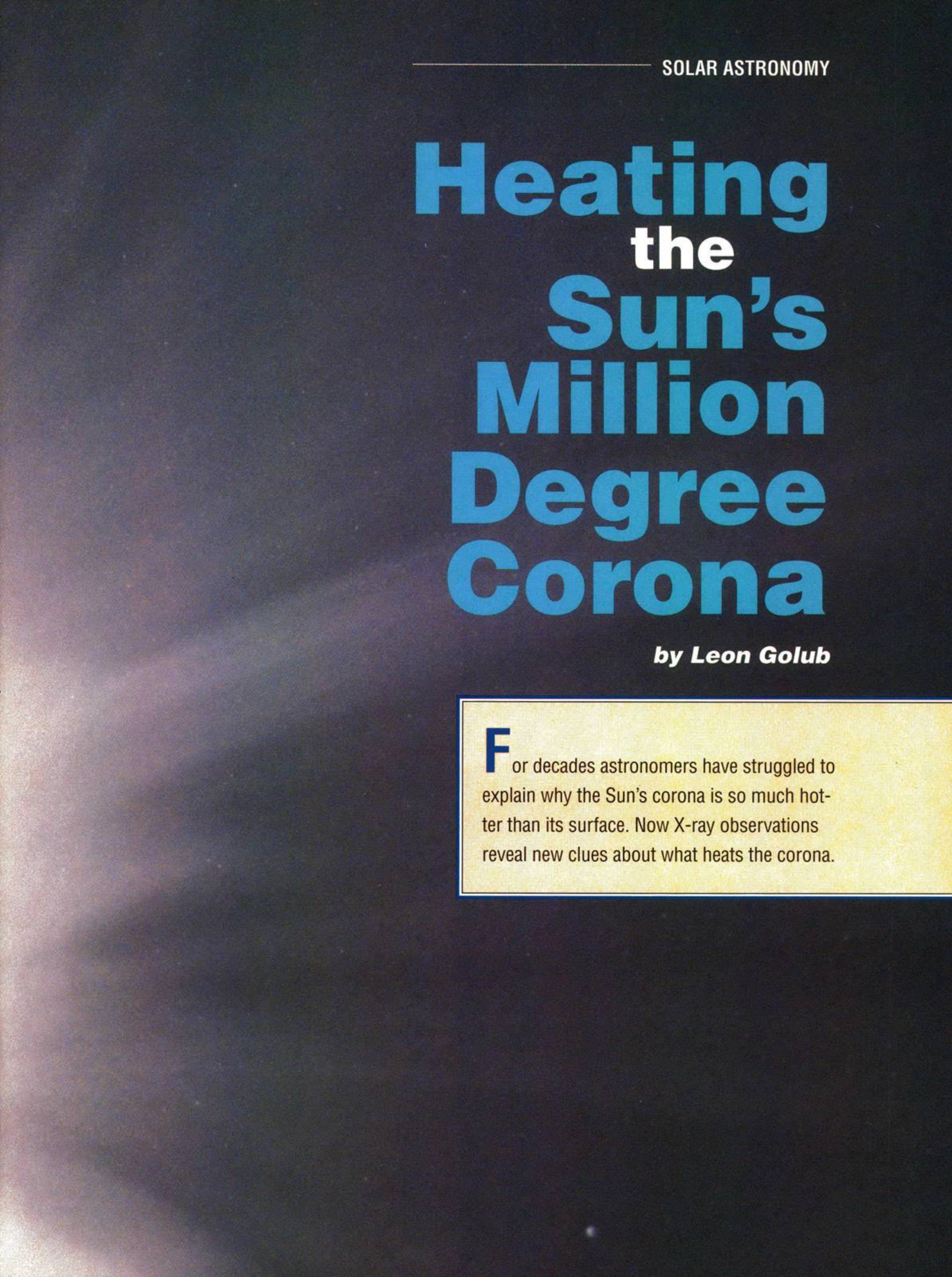


Heating the Sun's Million Degree Corona

by Leon Golub

For decades astronomers have struggled to explain why the Sun's corona is so much hotter than its surface. Now X-ray observations reveal new clues about what heats the corona.

IBM Research and Smithsonian Astrophysical Observatory

A total eclipse begins. The Moon blocks off our everyday Sun and in its place reveals a beautiful flower of gauzy light: the solar corona. Bright near the Moon's edge and fading into the twilit sky, the pearly corona appears unforgettably lovely and serene to every eclipse watcher.

But looks deceive. In reality, the corona is violently turbulent and unimaginably hot — vastly hotter than the surface of the Sun itself. Explaining how it gets so hot has stumped generations of astronomers — until recently. New X-ray observations point toward a mechanism that links the Sun's surface and the improbably hot corona.

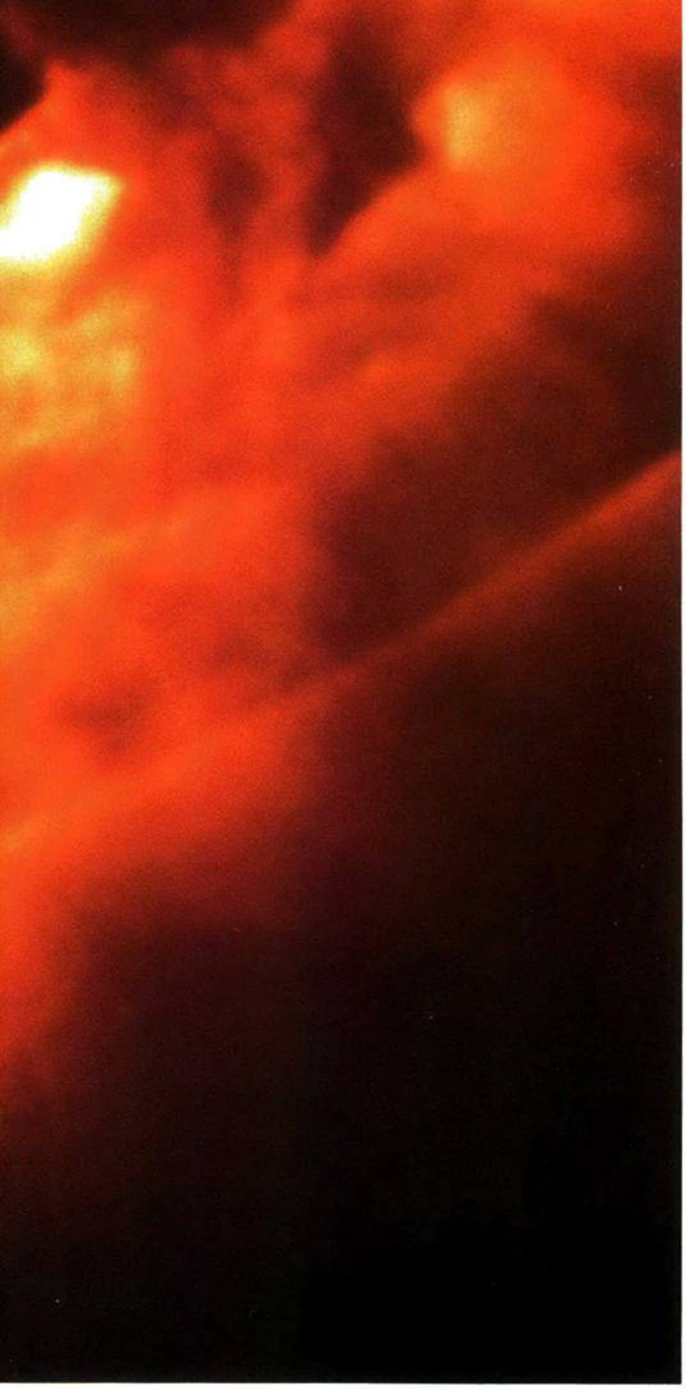
Observations of the corona don't tell us about just our star. The Sun forms the basis by which we understand all other stars. Understanding why our Sun has a corona explains why some stars have a corona and others don't. It provides a key to learning how every other star in the universe works.

Supercharged Elements

Astronomers began to study the corona after the total solar eclipse that was visible from southern Europe in 1842. But the nature of the corona remained a puzzle for a century, largely because researchers couldn't explain the mysterious lines they saw in the spectrum of the corona.

In particular, the wavelength of a coronal line that appeared in the green part of the spectrum did not match that of any known element. The solution came in 1939 from the Swedish astronomer Bengt Edlén, following a suggestion by Germany's Walter Grotrian. He showed that ordinary elements such as iron, calcium, and nickel emitted the coronal lines but under conditions never before witnessed in any object.

Although the lines were emitted by ordinary elements, they didn't come from ordinary species of the elements. They came from atoms that had a large number of electrons stripped away (or in scientists' terminology, were



CORONAL LOOPS RISE above regions of magnetic activity on the Sun's surface and follow the shape of the magnetic fields. Magnetic fields are one component needed to heat the corona to over a million degrees.

highly charged or ionized). In the case of the green coronal line, 13 out of 26 electrons of an iron atom have been removed. Edlén realized that the highly ionized state of the atoms can only occur if the coronal gas is extremely hot, a million degrees or more.

With Edlén's discovery, astronomers realized all of the unusual characteristics of the corona and its spectrum were caused by its high temperature. But instead of solving the coronal puzzle for astronomers, it merely shifted their questions to what heats the corona.

Pumping Heat from Below

Even though the visible surface, or photosphere, of the Sun is quite hot, most of its heat is lost to space in the form of light. A small fraction of this light heats the planets and sustains life here on Earth. Back at the Sun, a tiny bit of the photosphere's heat rises somehow into the corona.

The photosphere has a temperature of roughly 6,000 kelvins. While this is hot by Earth standards, the temperature is nowhere near the million kelvins of the corona. To make matters more difficult, as heat from the surface moves into the much larger volume of the corona, the temperature should go down, not up. The corona doesn't merely share the warmth of the photosphere, something must heat the coronal gas.

The Sun can't simply transfer heat from the cooler photosphere to the hotter corona, just as the air above a burner on a stove will not get hotter than the heating element itself. The Sun needs some additional mechanism to concentrate the little bit of heat that escapes into the corona and to boost the temperature of the corona to a million degrees.

> The Sun's magnetic field plays a crucial role in the formation and heating of the corona.

There are lots of ways to pump heat from a cool gas to a hotter gas, so scientists have constructed many different models of heating mechanisms for the corona. Unfortunately this has resulted in an embarrassment of riches — too many theories — because too many ways to heat the corona exist. This situation results because only a tiny portion, about one-millionth, of the Sun's total energy needs to be diverted into the tenuous coronal gas to heat it to a million kelvins. The role of observers is clear-cut: to sort out the many competing ideas.

Magnetism Provides One Key

Fortunately observers have succeeded in ruling out many theories, and together theorists and observers have established one basic fact: the Sun's magnetic field plays a crucial role in the formation and heating of the corona.

Motions deep in the Sun generate the magnetic field. The field mostly remains submerged below the Sun's surface between the two poles, but sometimes it "leaks" through the surface and forms regions of activity that can include pairs of dark sunspots. So solar astronomers divide the surface into "quiet" regions with relatively little magnetic field and "active" regions with strong concentrations of magnetic fields. This division of quiet and active regions carries into the corona. The active corona attracts more attention because it is hotter and more likely to reveal how the corona is heated.

The active corona contains mostly loop-shaped features that form above active regions in the photosphere and arch along the magnetic fields as they rise above the active region. Coronal loops appear hot and bright

Serge Koutchmy, CNRS, and IBM/SAO

SUPERIMPOSING X-RAY AND VISIBLE LIGHT IMAGES of the corona permits astronomers to see how features in different parts of the corona are related.

and emit strongly in the X-ray part of the spectrum. (See the photo on page 28.) They have a height roughly equal to the diameter of the active region because the strong magnetic field confines the hot coronal gas in the loops near the Sun's surface. The difference between the long streamers in the quiet corona and the intense loops reflects clearly the difference between their magnetic fields. The differences also suggest that the two regions have separate heating mechanisms.

Although observations show that the active corona and strong magnetic fields are related, the presence of a magnetic field may not be enough by itself to sustain the corona. Some astronomers have suggested the magnetic field acts passively by trapping some of the solar energy as it flows outward, like putting a lid on a boiling pot. Regions of stronger magnetic field would trap more heat and produce a brighter, hotter corona than regions of weak magnetic field, just as seen in the observations.

Researchers recently discarded these passive-trapping models because the slow-changing magnetic field can't explain the observed rapid variation of X-ray emission in coronal loops. This means that the amount of energy going into the corona must undergo rapid changes. So the magnetic field somehow heats the corona in a more direct and active way.

Flares: Small But Powerful

One way a magnetic field in an active region may directly heat the corona is through the sudden release of energy by a flare. Even a small flare can emit enough energy to power the electrical needs of the United States for thousands of years. Gas motions in the active region create this energy by twisting the magnetic fields. The magnetic field can store an incredible amount of energy because of the enormous size of the active region, over 1,000 times the volume of Earth.

Flare events can occur over a large range of sizes, among them coronal mass ejections that take the form of expanding magnetic bubbles and can become as large as the Sun in diameter, flares in active regions, and so-called microflares that occur within the smallest observed structures of the coronal fields. All of these events have as their common theme the sudden release of energy that was stored in magnetic fields.

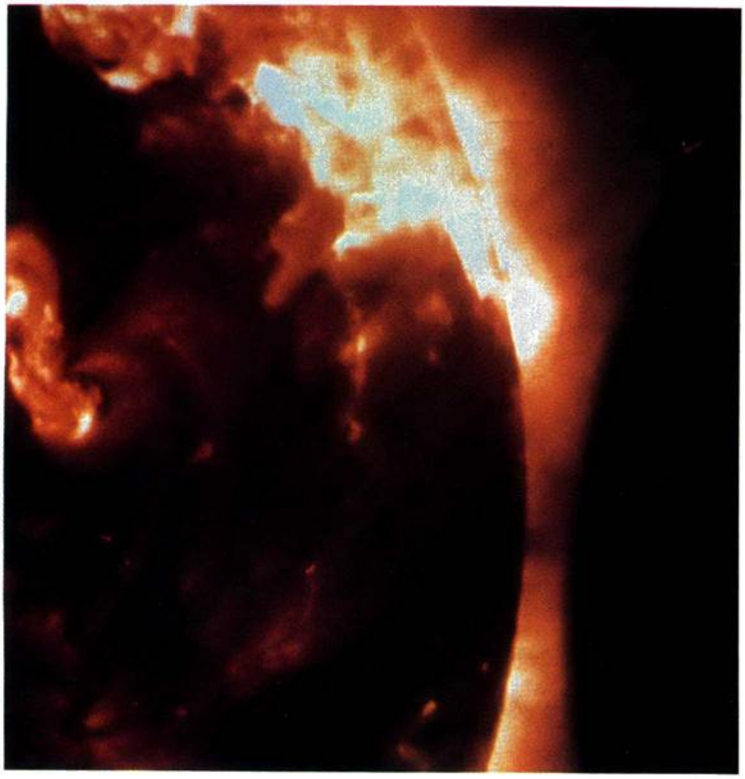
The smallest flares are far more numerous than large eruptions and might produce steady heating of the hot corona. This idea directly connects the magnetic field with an active mechanism for heating the corona. Observers are now looking for rapid variability of small coronal loop structures to test this idea.

> **Numerous small flares may cause the steady heating of the hot corona.**

Recent observations made by an X-ray telescope built by IBM and the Smithsonian Astrophysical Observatory (SAO) have provided a step in this direction. This telescope flies on a sounding rocket that carries the instrument above Earth's X-ray-absorbing atmosphere for a few minutes before returning to the ground.

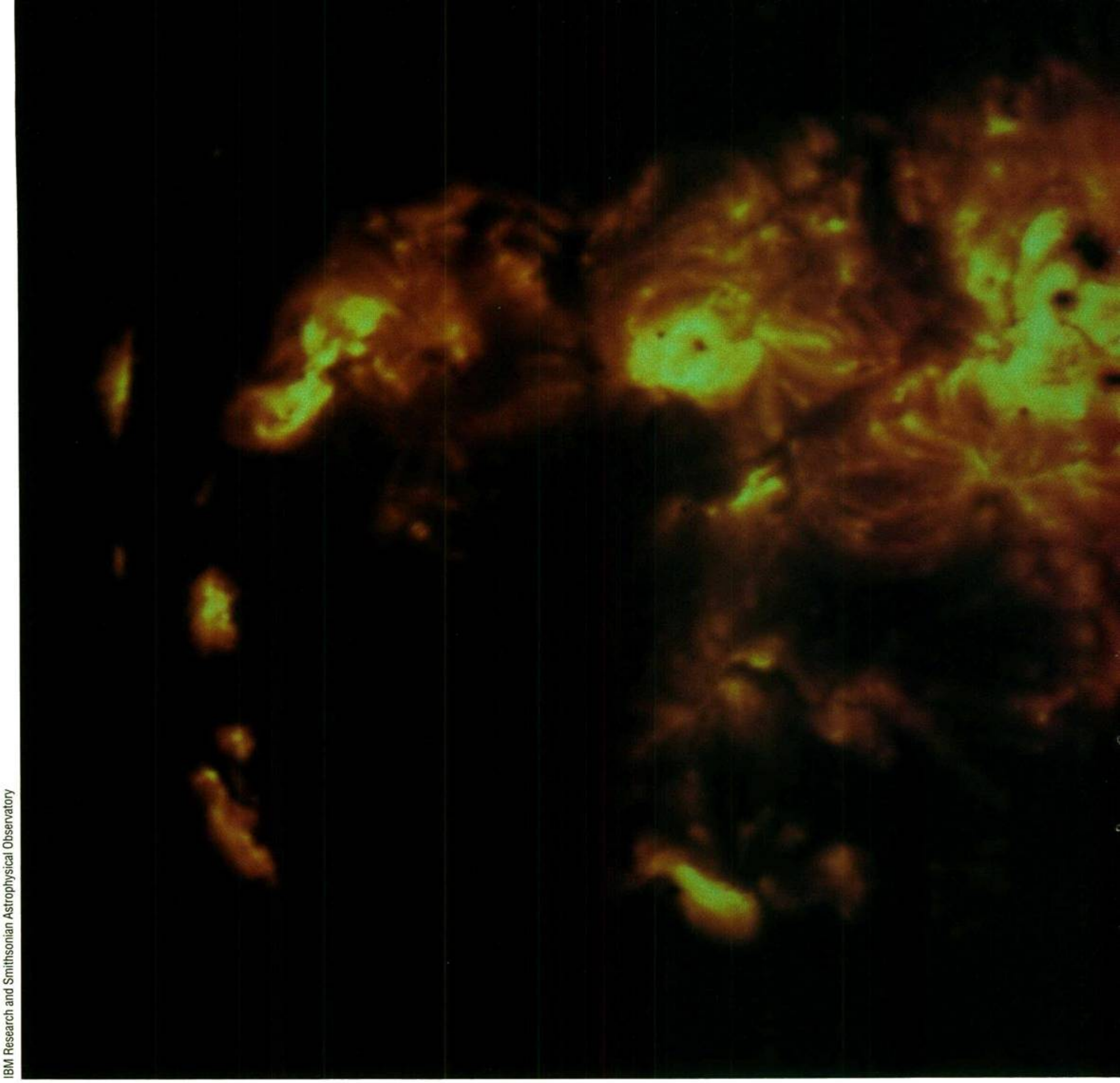
With this high-resolution telescope, astronomers have glimpsed how small, isolated patches in some coronal loops brighten and then join to form a continuous bright structure. The brightenings appear in a spiral pattern around the coronal loop, much like a screw thread, suggesting that the heating occurs along spiral-shaped magnetic fields in the loop.

These spiral-shaped patterns in coronal loops show that coronal heating is complex and rapid. No matter where energy flows into the loop — either from the bottom ends or from the top — heat conducts rapidly along the magnetic field to fill the loop. In a typical loop, any small-scale differences in heating will disappear in about a minute. That makes observing changes in the heating of a loop immensely difficult.



IBM Research and Smithsonian Astrophysical Observatory

OBSERVING THE CORONA in X rays during the July 11, 1991 total solar eclipse revealed many loops and arch-shaped features. The loops may be only 1 kilometer across, much smaller than present telescopes can resolve.



IBM Research and Smithsonian Astrophysical Observatory

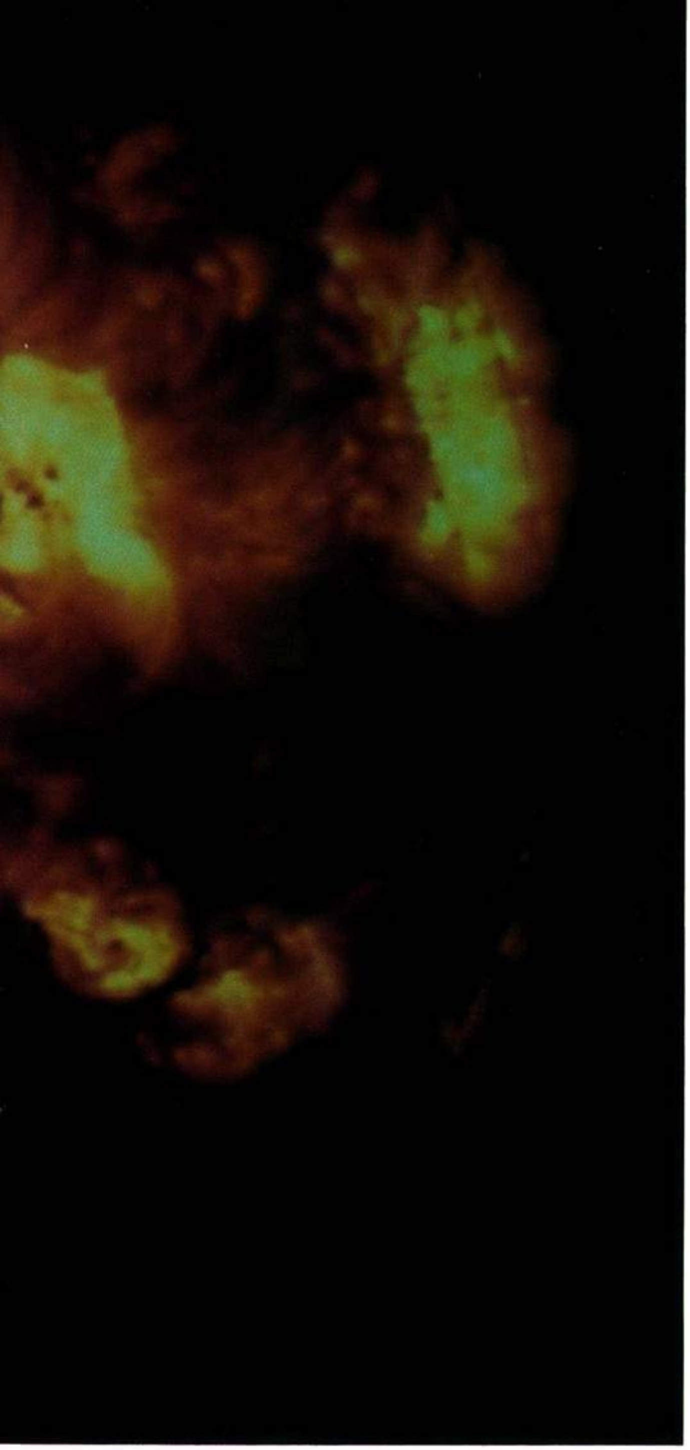
At the same time magnetic fields channel heat along the loop they prevent motion of thermal energy across the loop. Recent high-resolution X-ray images confirm this and show that the cross section of a loop is much smaller than previously thought. The diameter of a loop may be as small as about 1 km. Unfortunately this structure is nearly a thousand times finer than astronomers can see with their present instruments.

Besides loops and flares, one of the most obvious signals of the Sun's magnetic field is a sunspot. Sunspots usually come in pairs, as if a bar magnet were lying horizontally just beneath the visible surface. Spots appear at the poles of the magnet, in the places where the magnetic field is strongest in the active region.

The space above the photosphere should be filled with strong magnetic fields connecting the two spots. But the corona above sunspots displays a paradoxical behavior: Even though the corona is generally hottest and brightest above the location of strong magnetic fields, hot coronal emission appears absent directly above sunspots where the surface magnetic field is strongest. This provides another clue about how the corona is heated.

Turbulence Is Important, Too

A recent rocket flight of the SAO/IBM high-resolution X-ray telescope presented a unique view of sunspots and the corona above the spots. The telescope recorded a small amount of visible light at the same time as it recorded the X-ray image. (See the photo above.) Thus it showed simultaneous images of the spot and the corona above it.



SEEING THE CORONA ABOVE A SUNSPOT in this combined X-ray and white-light view revealed that turbulent gas motions at the Sun's surface are a key factor in the process that heats the corona.

As this picture shows, bright corona exists around spots, where the magnetic fields have moderate strength and arise from the turbulent material of the photosphere. The dark center of the spot, or umbra, contains the strongest magnetic field. But no hot coronal material emanates from there, even though strong magnetic fields extend into the corona above the spot umbrae.

So magnetic fields by themselves do not heat the corona. Something else must also be at work. The lighter region around the umbra, called the penumbra, may provide a clue to the identity of this mechanism.

Moderately strong magnetic fields exist in the penumbra, and coronal loops appear to rise from this region. The gas in the penumbra is believed to be convective, like the gas in the surrounding photosphere. Convection carries heat from place to place by turbulent motions of the gas, rather than by the radiation of photons of light.

More important, the turbulence can push magnetic fields around, while strong magnetic fields can reduce or even prevent convection. Penumbral regions form a transition between umbrae and the surrounding photosphere. The photosphere has strong convection, magnetic fields of moderate strength, and hot corona with its strong X-ray emission, while umbrae have drastically reduced convection, strong magnetic fields, and little hot corona.

Apparently, because an umbra has only weak convection inside it, not enough energy feeds up into the corona to produce detectable X-ray emission. So in order to have a strong corona, a region must have a strong magnetic field and an activator, such as turbulence in the gas from which the field arises.

> **Strong magnetic fields are not enough to create a hot corona; something must activate the field.**

Looking for Answers

Present high-resolution X-ray observations provide a tantalizing glimpse into the magnetic and turbulent processes that structure and heat the corona. But so far it remains only a glimpse. Now astronomers need additional observations of coronal loops to confirm their ideas about the mechanisms that heat the corona.

They need more high-resolution observations so they can view the thin cross sections of coronal loops and lengthy sequences of observations so they can study the heating of a loop during its entire heating cycle.

Unfortunately, rocket flights last only a few minutes, and coronal structures evolve over periods longer than this. Satellites such as Yohkoh, the X-ray satellite launched in 1991 by the Japanese, can't image loop structures with the high resolution needed. So solar astronomers are starting to plan for a new generation of high-resolution instruments that will orbit above Earth's atmosphere so they can peer deeply into coronal loops and better learn how they are heated.

Understanding the Sun's corona has already paid dividends in uncovering why some stars have a corona and others don't. When astronomers have a firmer knowledge of the Sun and its corona, they will better understand other stars and the light coming from the stars of other galaxies. □

Leon Golub is a physicist at the Smithsonian Astrophysical Observatory. His article "The Violent Sun" appeared in the February 1990 issue.

MOTES IN THE SOLAR SYSTEM'S EYE

How can tiny, high-speed meteorites help give astronomers the big picture on how planetary systems form?

By Thomas Brophy

Bruce Bond

Where they came from is anyone's guess. The largest was barely big enough to see by eye, and if you wanted to examine the smallest you'd need a high-power microscope.

In any case, between April 1984 and January 1990 a handful of tiny meteoroid particles — dust motes — flew past Earth at very high speed. Ordinarily, no one would ever have known about them. Who could find such things in all the vastness of space?

Yet these particles were lucky. They missed Earth but they hit NASA's Long Duration Exposure Facility satellite.

LDEF ("ell-deff") was a 30-foot-long spacecraft that spent nearly 6 years orbiting Earth with the sole purpose of being struck by meteoroids and cosmic debris. After astronauts recovered the craft, project scientists pored over it. They estimated how large every impacting particle had been by the tiny crater it left — and how fast it was traveling when it hit. One scientist, J. A. M. McDonnell of the University of Kent at Canterbury, England, found pay dirt. He reported that some particles that struck LDEF were traveling at very high speeds. In fact, their speeds were so high the particles probably came from outside our solar system.

Objects from beyond the Sun's domain — extrasolar materials — fascinate astronomers because they give a direct look at things created elsewhere in the Milky Way Galaxy. The LDEF finding, while still controversial, means that in the future scientists may be able to detect and even study material coming from other star systems with relatively simple means. The little particles may also help astronomers with one of the ultimate goals of planetary science: searching for planets around other suns.

Micrometeoroids and Macroplanets

What do microparticles have to do with planets? To understand the connection, let's follow the formation of a planetary system. Only we won't view it with a telescope as an astronomer might. Instead we'll use our mind's eye to see it from the point of view of a participant — a single carbon atom, for example.

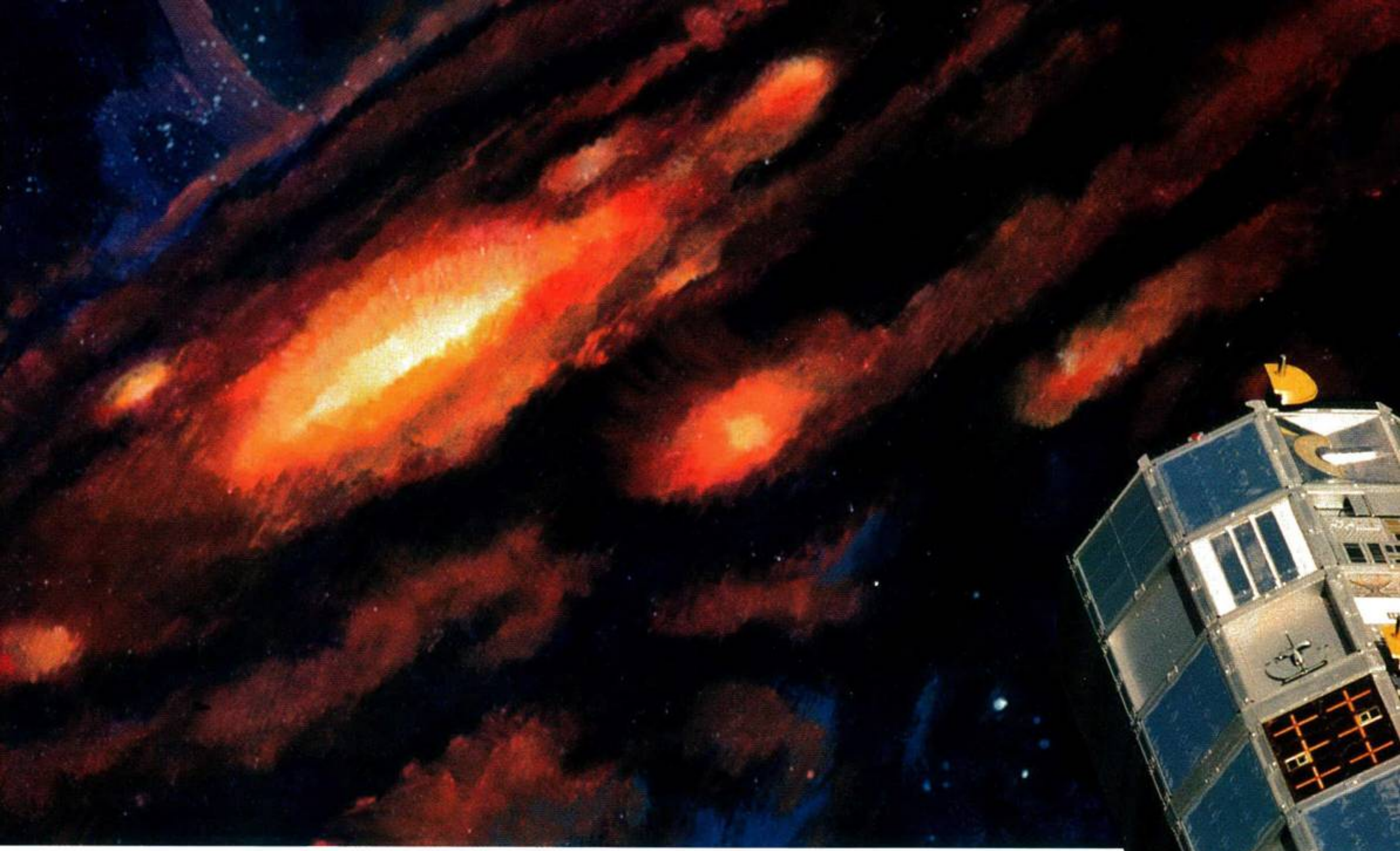
Some billion or more years ago the carbon atom was born in the heat of a dying star's core. At the end of the star's life cycle, the atom was ejected as part of a grain of graphite into interstellar space. It drifted through a giant molecular cloud in the disk of the Milky Way, joining debris from other now dead stars. The cloud was clumpy and the grain fell into an especially dense clump, where gravity pulled it inward toward the center. The clump became denser and warmer as other grains fell into it. Then as pressure built, the outer part of the clump flowed back into the cloud, while self-gravity caused the inner clump to continue collapsing and heating up.

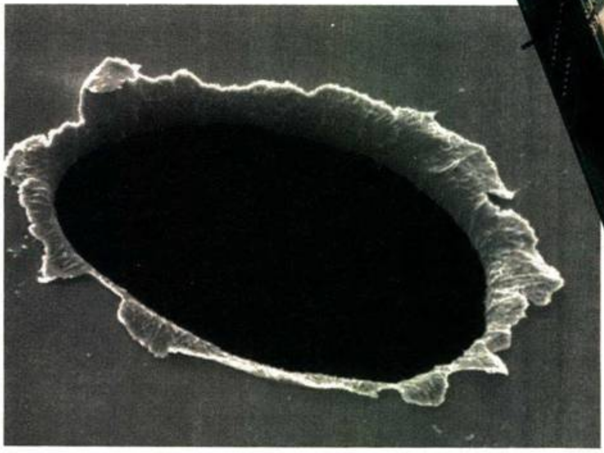
Of all the multitudes of carbon atoms in the inner clump, 9 out of 10 fell into the protostar growing at its center. One out of 10 — including our atom — ended up in a turbulent disk of dust and gas orbiting the protostar. Jostled and heated by shock waves and the gravitational tugs of many bodies, the atom had an uncertain fate. It had roughly a 50-50 chance of either joining one of the nascent planets or merging into one of the comets, asteroids, rocks, and other debris.

Close to the protostar, temperatures were high, so water and other easily evaporated substances remained gaseous. The developing planets here were rocky and the debris was asteroidlike. Far from the protostar, however, icy and gaseous planets could form and the debris was cometary: about two-thirds water ice and one-third rock.

The carbon atom joined the asteroidal debris, which collided and shattered and re-coalesced in repeated buffeting by gravitational encounters. But the atom (and most other asteroidal and cometary debris) was ultimately ejected from the newborn planetary system. It was exiled back into the void a mere 10 to 100 million years after the system began to form.

This fate is common. Only a small fraction of the original disk of material remains gravitationally bound to a new star. Some asteroids will mingle amongst the planets, and multitudes of comets will hang out on the far edge of the star's gravitational field. But most of the material is cast off by the star, tossed back into interstellar space by slingshot encounters with the planets.





Unit for Space Sciences, University of Kent, Canterbury

ZAP! YOU'RE HISTORY. Tiny pieces of interstellar debris may be so abundant that astronomers can sample them with "target" spacecraft like NASA's Long Duration Exposure Facility (right). This 50-micron crater (above) on one of LDEF's panels may have been blasted by a high-speed particle that traveled light-years to reach Earth.

NASA

Eventually such castoff debris may end up in another star or its planets.

Our carbon atom became part of a microscopic particle hurtling through the interstellar medium. The galactic disk is so empty that it flew unimpeded for more than a billion years. Then the particle neared another star, the two objects closing at dozens of kilometers per second. As the particle fell into the star's gravitational field, it sped even faster. Barely missing the star, the particle smacked into a plate of sheet metal that was orbiting a small rocky planet not unlike those it left behind a billion years before.

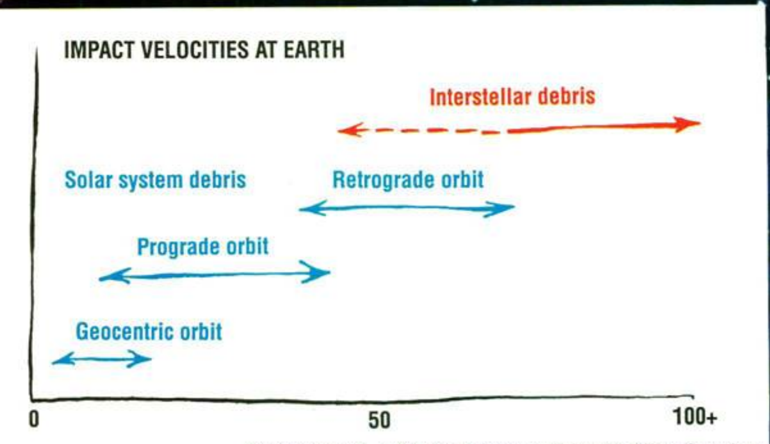
Soon after, the beings that dwell on the planet put the metal instrument into their space truck and took it home. Examining the plates closely for impacts, they found that the particle had struck so fast it must have come from beyond their solar system. Some of the beings refused to believe that anything could come from beyond their own solar system. Others, sensing a connection to the Galaxy beyond the system, grew excited.

Where Are the Extrasolar Comets?

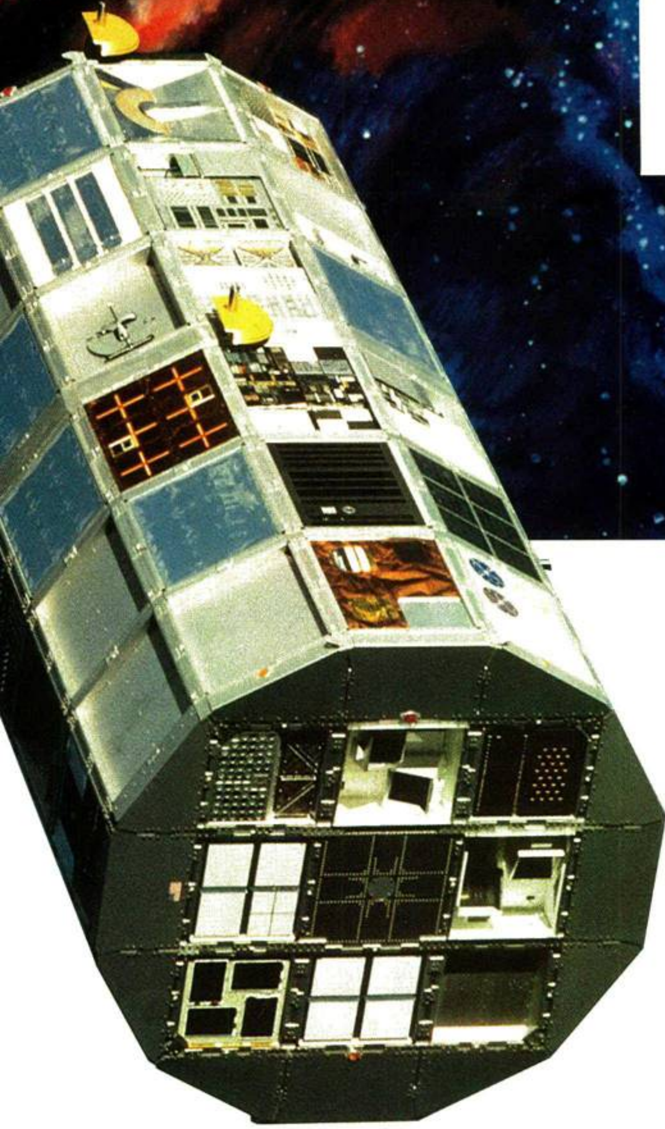
Why care about bits of stuff too small to see? The answer goes right to the heart of how astronomers think the solar system was created. Many scientists now believe the ejection of debris, large and small, is integral to the formation of planets and stars. This fugitive material — ranging from dust to comet-sized bodies — is impossible to detect in interstellar space. Not so when it nears a star.

Each time a comet appears in the sky, astronomers track it with telescopes and define its orbit. Virtually all the comets we see are believed to come from the Sun's Oort Cloud, an hypothesized shell of deep-frozen comets that extends from beyond the orbit of Neptune to about halfway to the nearest star, a distance of about two light-years. Short-period comets, such as Halley's, travel on tightly bound orbits about the Sun; long-period comets reach deeper into space and may be "new" in that they have not entered the inner solar system before. But both long- and short-period comets alike have orbits bound to the Sun by gravity.

Planetary astronomers generally accept the Oort Cloud as the origin-place for comets in our solar



Sunil Deshpande, Unit for Space Sciences, University of Kent, Canterbury



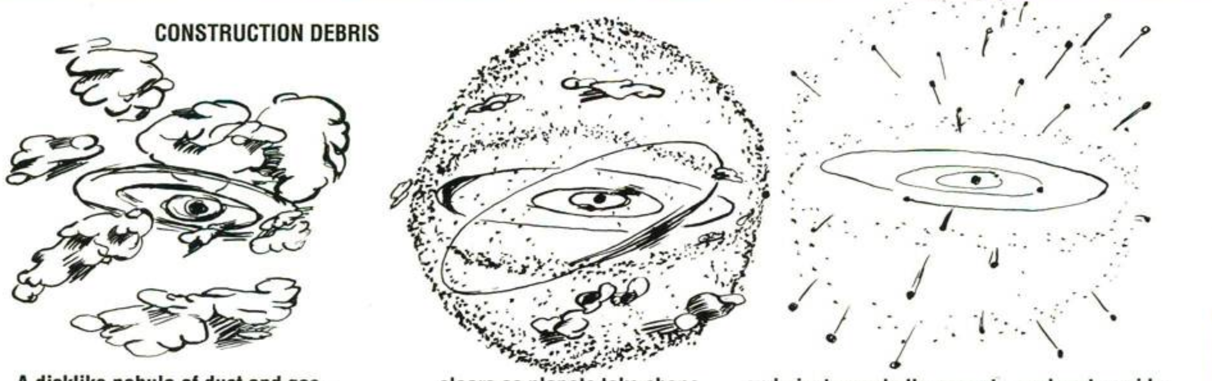
LEAD-FOOTED LOCAL OR JUST PASSIN' THROUGH? You can't always tell by its speed whether a particle belongs to the Sun or is an interstellar traveler (above left). Making planets is messy because most of the raw material is thrown back into deep space (above right).

system. The difficulty comes when they extend the Oort Cloud hypothesis to other planetary systems. One model for creating the Oort Cloud says that during the formation of the solar system, comets were thrown out there by gravitational encounters with Jupiter, Saturn, Uranus, and Neptune. But in dynamical terms, the Oort Cloud is a hard target to hit precisely with a thrown comet — if the velocity is only a little bit too high, the comet will be irretrievably lost to space. Most comets escape. Predictions say that for every one that lodges in the Oort Cloud, a great many more will sail right through it, out of the Sun's grasp forever.

If other solar-type stars form the way the Sun did, many of these stars will have planetary systems and Oort Clouds of their own. The formation of all these Oort Clouds in the Galaxy should result in countless numbers of rogue comets sailing through interstellar space. (In astronomers' jargon, such comets are called extrasolar.) Their numbers pose a problem. Calculations show that from here on Earth, about 6 obviously extrasolar comets should have been seen in the last 150 years. Extrasolar comets would stand out clearly from our local Oort Cloud ones by their hyperbolic, high-speed trajectories past the Sun. But no such comets have been observed, despite good observational records that go back 250 years or more.

Is the Oort Cloud theory flawed? Perhaps. If the discrepancy continues to persist, astronomers may be forced to conclude either that planetary systems similar to our own are rare — or that our ideas on how solar systems are born need rethinking. But because many poorly understood factors enter into the calculations, the problem may not yet require a completely new model.

One assumption the present theory makes is that extrasolar comets are distributed evenly throughout our region of the Galaxy, much as the stars themselves are. Astronomers say that they are "well mixed." Since the planets in a solar system orbit in a plane, the comets tossed out at the system's birth would have initially been ejected mostly in that plane. But planetary systems will have random orientations. Over any rea-



CONSTRUCTION DEBRIS

A disklike nebula of dust and gas... clears as planets take shape... and eject snowballs, comets, and meteoroids.

Tom Hunt

sonable time span (or mixing time), the Galaxy's extrasolar comets should be well distributed in three-dimensional space.

Perhaps one reason we haven't seen any extrasolar comets is that the Sun happens to be in a local void where there are few of them — although over a long enough time the number of encounters would average out the same. Astronomers agree, however, that they need a detailed calculation and a better understanding of the formation of the Oort Cloud.

Faced with the extrasolar-comet shortage, some astronomers have proposed intensive searches to spot them passing by the inner solar system. One possible candidate turned up in recent years: Comet Yanaka (1988r). This comet flew past with a velocity high enough to take it right out of the solar system. But Yanaka stands out not so much for its velocity as for its unusual chemical composition, which is greatly deficient in carbon compounds. Unfortunately, Yanaka was so unusual that astronomers can't tell if it was a true interstellar wanderer or simply a very strange Oort Cloud comet with a gravitationally perturbed orbit.

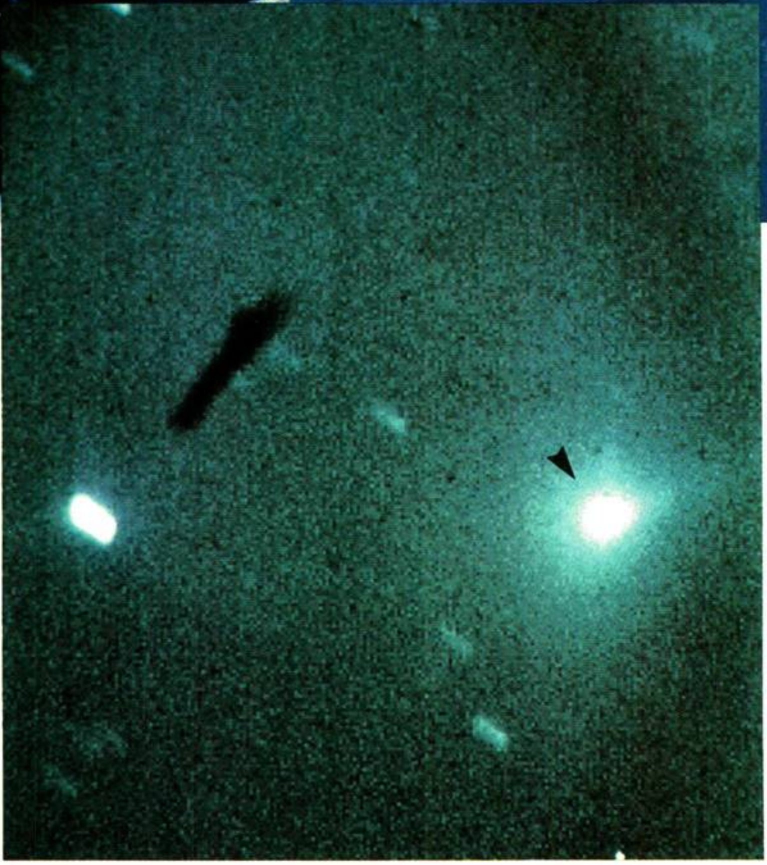
Faced with uncertainties in comet searches, other astronomers take a different approach. They note that populations of astronomical debris are typically composed of objects in a wide range of sizes. The easily detectable objects are really just the largest things in a spectrum that contains mostly smaller ones. If the number of observable extrasolar comets has fallen far short of expectations, that's not all the extrasolar debris there is. Besides comets there should be lots of smaller pieces. And the tiniest such particles may actually be so abundant that perhaps all astronomers have to do is put something pristine out in space for a time and then examine it for damage: hence LDEF.

Extrasolar Meteoroids?

But how do you sort dust from dust? Scientists can separate extrasolar dust from the local variety by the former's high velocity. But how do they know a given extrasolar particle comes from a planetary system and not from some other astronomical process? Size may be one key. Astronomers think that much of the dust in interstellar space was ejected from stars by ordinary processes such as nova explosions and the red-giant phase of a star's evolution. Ordinary interstellar dust is made up mostly of very small particles — 1 micron ($^{1}/_{1000}$ millimeter) across or less — while LDEF's best candidates for extrasolar particles were 5 to 10 microns across. Second, dust that is 1 micron in size or smaller is strongly repelled by radiation pressure and electromagnetic forces, which abound in the inner solar system. Such tiny dust particles might never make it as far into the solar system as Earth's orbit.

Another approach is to look at quantity. If scientists can guesstimate how much cometary material gets ejected in the formation of a planet system, then they can model how much smaller stuff should accompany it. One hitch is that no one knows how small a comet can be, because very small comets are unlikely to be observed, even within our own solar system. Still, crude calculations of comet numbers show that there should be enough 5-micron particles to agree with the number of possible LDEF detections.

Given that small extrasolar meteoroids can plausibly arrive in detectable amounts, the next step is to determine as precisely as possible the likely number of particles in each size range for different kinds of materials. Astronomers use the same calculations that gave the expected number of observable extrasolar comets and extend it to include all sizes of particles. For in-



Uwe Fink, Lunar & Planetary Laboratory, University of Arizona

OFF-SHORE IMPORT? Its chemistry radically unlike that of other comets astronomers have seen, Comet Yanaka (1988r) (left) may have been born around another star and captured by the solar system.

stance, high-speed collisions of rock and ice — ice behaves like rock at interstellar temperatures — yield specific numbers and sizes of particles. (This distribution of sizes is also close to that found in the present-day asteroid belt.) Combining these figures with the amount of ejected material predicted by Oort Cloud formation models says that an LDEF-sized detector will have many "hits" per year.

This result is exciting because scientists currently think that all meteoroids impacting Earth belong to our solar system. It's worth remembering here that astronomers didn't believe that rocks could fall from the sky at all until the late 1800s. Even Thomas Jefferson wrote of a reported meteorite fall in 1808 that the report of its "descent from the atmosphere presents so much difficulty as to require careful examination."

By the 1930s astronomers were thinking that most meteorites were of interstellar origin. But then photographs of meteor tracks indicated that they came from orbits bound to the Sun. Also, isotopic analyses of meteorite samples showed many stony-type meteorites had crystallization ages just slightly older than the age of the Earth. In fact, these meteorite ages were all so consistent that they came to define the age of the solar system. In recent years, dynamical studies of the asteroid belt have shown that most meteorites can be supplied by Jupiter's gravity perturbing the main belt, with subsequent collisions sending fragments onto Earth-crossing orbits. Finally, other studies indicate that some meteors, especially those that completely vaporize in Earth's atmosphere and don't reach the ground intact, may come from the Oort Cloud and from comet tails. So in the last 60 years, the pendulum of thought has swung the other way and meteoroids are now considered solar.

Most surely are. But growing evidence suggests that

at least some are not. Years ago, a radio observatory in Czechoslovakia studied the trains left by submillimeter-sized meteors. The scientists reported that a small percentage of their detections had extrasolar velocities. The flux of particles implied by the detections roughly matches that predicted from solar system formation models. At the time of observation, astronomers paid little attention to the anomalous data, but this is now an area for further research.

Moreover, no systematic study has ever set an upper limit on the fraction of meteoroids, meteors, and meteorites that could come from extrasolar sources. If extrasolar meteors contribute as much as about 1 percent to the total, it wouldn't contradict the observations so far. Indeed, calculations show that given our present understanding of planet formation, around one meteor in a thousand *should* be extrasolar. Searches for comets that are clearly extrasolar have been fruitless. But these depend too much on luck, on chancy observations of rare events: one short-lived extrasolar comet every several years.

So maybe planetary astronomers have been looking at the wrong kinds of objects. Given that small extrasolar debris (meteoroids, meteors, and maybe meteorites) is continuously pelting Earth, searches for it and studies of its properties might yield a more detailed understanding of extrasolar debris in general — and, perhaps, its role in planet formation.

Picking Over the Cosmic Dust Heap

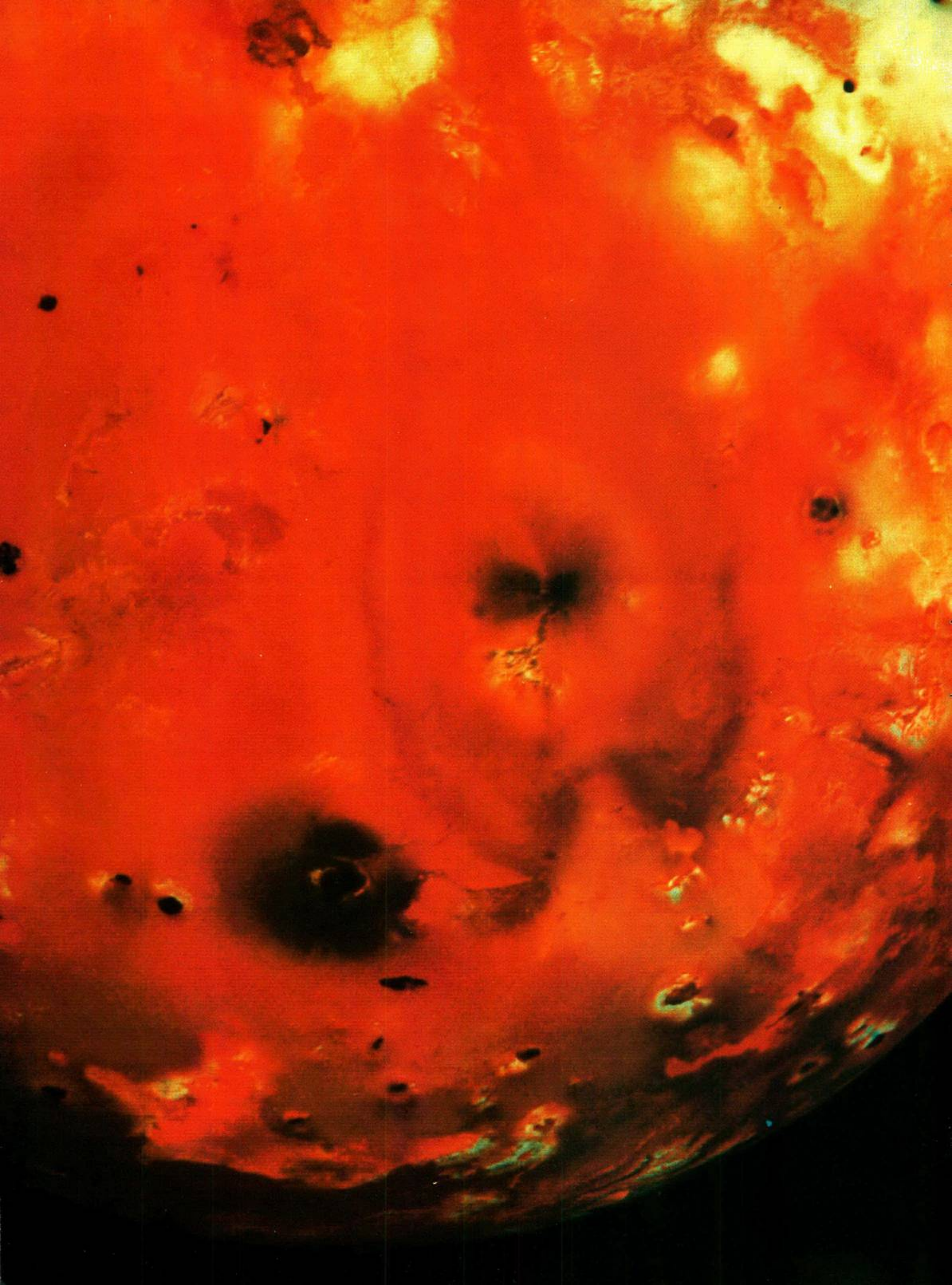
LDEF is just a first step. And scientists have not yet published conclusive analyses of its data. One member of the LDEF team has indicated that he thinks the initial report of extrasolar velocities for large particles was based on unclear data. Unfortunately, LDEF gave essentially no information on what direction its impactors came from. Particles orbiting the Sun in the opposite direction from Earth — retrograde — would strike with speeds the same as those of the slower-moving extrasolar impactors. You can't tell them apart. On the other hand, it would be strange indeed to find a large population of retrograde-orbiting small particles.

It may even turn out that the initial LDEF reports of extrasolar meteoroids were erroneous. But if planetary astronomers go beyond LDEF to conduct a focused search for extrasolar meteoroids, the result ought to be clear-cut. Either extrasolar meteoroids will reveal their existence, or astronomers' knowledge of planet formation will advance by significantly constraining the models. A next-generation LDEF detector, larger and with better velocity and size determination, could detect (or place upper limits on) the number of particles in the size range of several microns to tens of microns. An ideal place for such a detector would be the surface of the Moon, which has no atmosphere to filter out even the tiniest particles. If the detector were the size of a football field, it would increase the collecting area many-fold over LDEF. And newly proposed detection materials could provide direction, velocity, and size information — and perhaps even collect samples for analysis.

Nor is this all. A focused search for extrasolar meteors with radio and radar telescopes, effectively using Earth's atmosphere as its "detector," could determine accurately the flux of extrasolar meteors in submillimeter sizes. Also, if scientists can devise an unambiguous test for extrasolar origin, they could search large numbers of small meteorites collected in Antarctica. These might well reveal a few samples from the births of other planetary systems.

Over a century ago, scientists accepted the idea that meteorites fall to Earth. Today, across a vastly larger picture of the universe, four threads of knowledge are being woven together: the theory of meteorite sources, the study of meteorite samples, the observation of meteor orbits and, finally, the detection of micrometeoroids high in the atmosphere and in space. All of these are working to greatly enhance our knowledge of the origin and evolution of the solar system. We may soon know that a small fraction of meteoritic debris is indeed the relic of another planetary system's birth. And in coming years, observations of such material might reveal valuable new knowledge about the formation and evolution of ours and other planetary systems. □

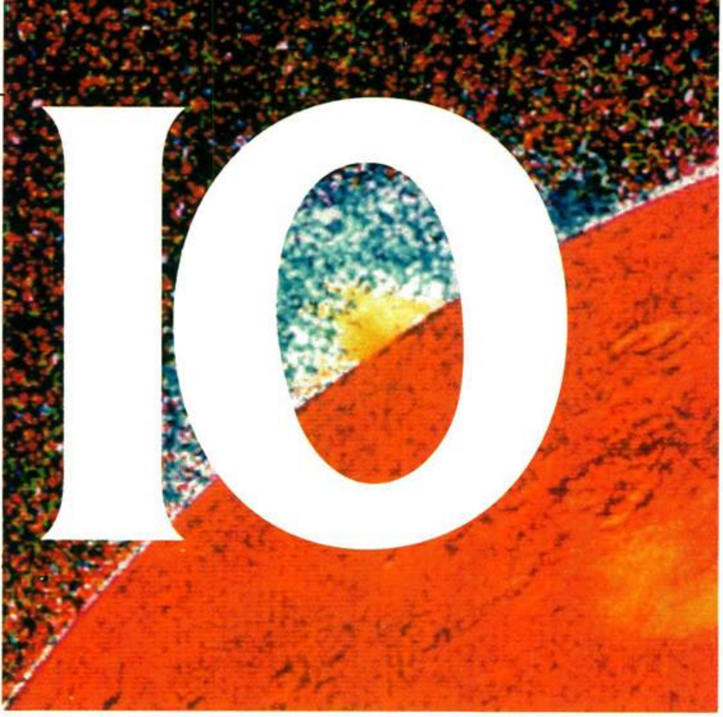
Thomas Brophy is a planetary astrophysicist with the Laboratory for Atmospheric and Space Physics in Colorado. His research specialties include the study of planetary rings and the formation of planetary systems.



The Violent Volcanos of Io

The volcanic fires of Jupiter's extraordinary moon Io rage at levels far higher than any seen elsewhere in our solar system.

by Richard Talcott



NASA/JPL

A HEART-SHAPED PATTERN OF DEBRIS surrounds Io's volcano Pele, shown here from directly above. Pele's sulfur-rich eruption was the largest seen by Voyager, spewing volcanic ash across more than 1,000 kilometers of Io's surface.

NASA/JPL

Fire and brimstone. The words bring to mind a hellish land of molten lava, of volcanos spewing sulfurous fumes high into a thin atmosphere. To astronomers, however, this place is not one to fear or avoid, but to scrutinize. For this environment belongs to a real world, Jupiter's remarkable satellite, Io.

When the Voyager 1 spacecraft discovered erupting volcanos on Io during its 1979 flyby, most astronomers were astonished by their sheer magnitude. Greeting Voyager's cameras were nine separate eruptions, each of which dwarfed anything ever seen on Earth. The images painted a picture of a world literally turning itself inside out.

Though spacecraft first revealed the volcanos' presence, astronomers are not sitting idly by waiting for the next space mission — the Galileo orbiter — to arrive at Jupiter in 1995. Thanks to sophisticated detectors on ground-based telescopes, they can now monitor Io from Earth. What they've found is a world that remains the most volcanic body in the solar system but one whose activity varies significantly over short periods.

Redder than Mars

Even before Voyager discovered active volcanos, Io appeared intriguing. Observers have studied this tiny world ever since 1610, when the Italian astronomer Galileo discovered Io and Jupiter's three other large satellites — Europa, Ganymede, and Callisto. For over 300 years, astronomers thought that the four Galilean satellites were similar to each other and to Earth's own satellite, the Moon.

That view didn't change until this century, when detailed observations with better equipment revealed Io as an oddball. In the 1920s, observers noted that Io's brightness and color varied significantly as it orbited Jupiter. And overall Io turned out to be the reddest body in the solar system, redder even than the Red Planet, Mars.

Two events in 1964 added to the intrigue. First, observations seemed to show that Io brightened abnormally as it emerged from Jupiter's shadow after an eclipse. (Surprisingly, the question of whether this brightening is real has yet to be settled.) Second, powerful radio bursts from Jupiter correlated with Io's orbital position, showing that Io was somehow linked to the Jovian magnetic field.

In 1973 the Pioneer 10 spacecraft performed the first closeup reconnaissance of Jupiter. Though it did not return any photos of Io, Pioneer 10 did provide an accurate value for the satellite's mass. When combined with the known diameter of Io (3,630 km), the mass yielded an average density of 3.6 grams per cubic centimeter, some 7 percent greater than the Moon's and what would be expected for a body of pure rock.

Perhaps most puzzling of all, ground-based observations in the infrared showed that when Io passed into Jupiter's shadow, its temperature fell faster at some wavelengths than others. Io baffled astronomers in the 1970s because so many of the observations simply didn't make sense. But then astronomers were thinking that Io was a cold, geologically dead world.

All that changed in March 1979, when Voyager 1 zipped through the Jovian system. Highly detailed photos of Io showed no impact craters on the satellite's surface. If Io were a dead world, it should have been pockmarked with impact craters, so their absence meant some process had to be destroying them.

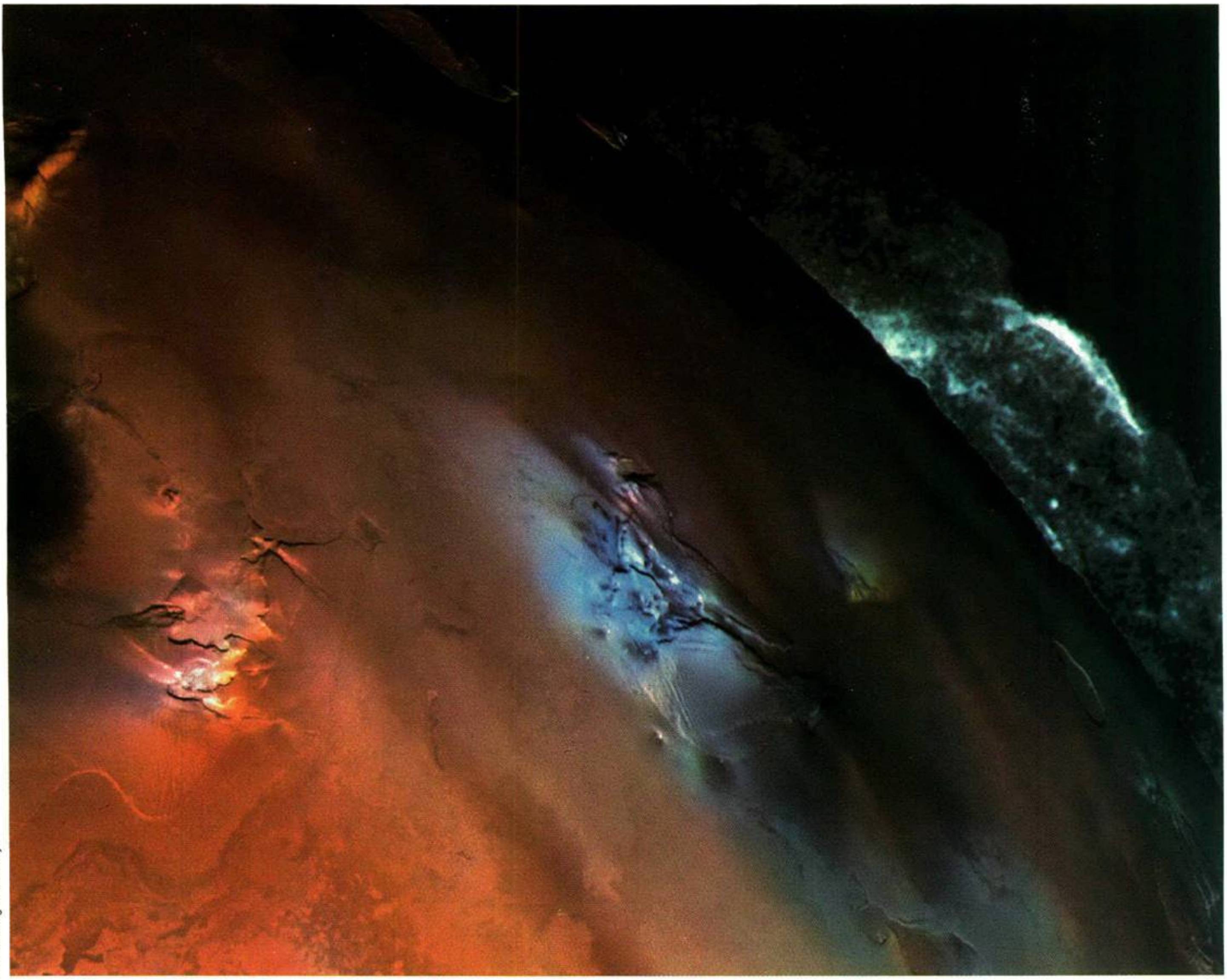
Plumes in the Ionian Sky

A few days later, astronomers solved the mystery — they saw active volcanos on Io! No less than nine volcanos were spewing vast plumes of material tens to hundreds of kilometers above the Ionian surface. The intensity of the volcanism is so high that Io resurfaces itself at a rate as high as 10 cm per year.

Eruptions on Io fall into two major categories. The volcano Pele typifies the first kind and, in fact, is the only example of this type Voyager actually saw erupting. Pele-type volcanos produce umbrella-shaped plumes that reach heights of 300 km and leave deposits over an area 1,000 km or more across. To reach such heights, the volcanic material must be ejected at speeds of about 1 kilometer per second (km/s).

Pele-type eruptions appear to be driven by sulfur vapor and are short-lived, lasting probably only several days to a few weeks. Pele itself had shut down by the time Voyager 2 flew by four months after Voyager 1. Two other volcanos, however, Surt and Aten, showed fresh deposits that indicated they experienced Pele-type eruptions during the interim.

The other eight plumes, seen by both Voyager spacecraft, are all similar to the volcano Prometheus.



U.S. Geological Survey

PELE ERUPTS, shooting a volcanic plume some 300 kilometers into Io's thin atmosphere. The eruption was brief, however, having ceased by the time Voyager 2 flew by four months after Voyager 1 took this image.

Prometheus-type eruptions are smaller than that of Pele, extending from 50 to 200 km above Io's surface and depositing material across a few hundred km. They spew out ash particles at 0.5 km/s and apparently last for years at a time. The best guess is that these eruptions originate in reservoirs of liquid sulfur dioxide at temperatures of about 400 K.

One volcano deserves special mention. Loki, though classified as a Prometheus-type volcano, may actually be an intermediate type. For a few days during the Voyager 2 encounter, one of its two plumes increased to near Pele-like levels.

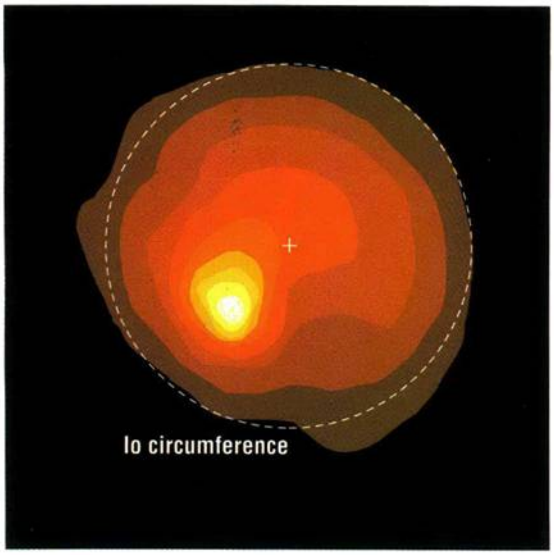
Voyager 1 also mapped the temperature of Io's surface with its Infrared Interferometer Spectrometer. (Voyager 2 passed too far away to measure heat from Io.) The instrument found hotspots associated with some volcanic plumes and with some other volcanic features that were not erupting. The temperatures of these hotspots ranged from nearly 400 K for Prometheus-type volcanos to 600 to 700 K for Pele.

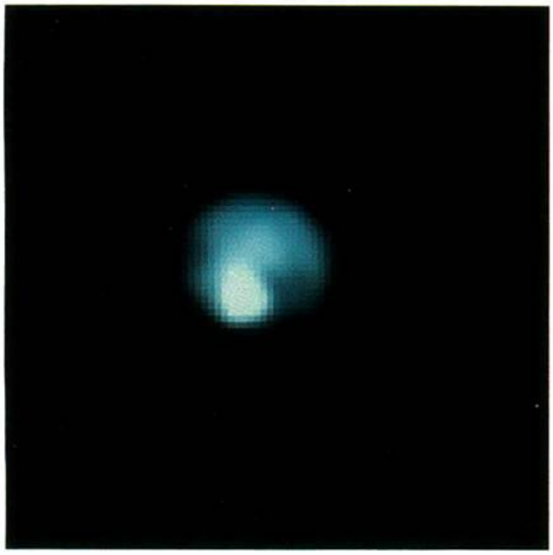
The Tide Is High

What's the ultimate source of the heat needed to generate all this volcanic activity? Astronomers generally consider two methods as ways for planets or satellites to produce enough internal heat to drive surface geological activity. The first is by the decay of radioactive elements. Long-lived radioactive elements such as uranium, thorium, and potassium can generate heat for billions of years as they decay. That's what powers volcanos and plate tectonics on Earth.

However, the smaller an object is, the less radioactive material it contains and the faster it radiates heat into space. Molten lava once flowed on the Moon's surface, for example, but that was billions of years ago. The Moon has now cooled to the point where its solid crust is several hundred kilometers thick. Because Io has roughly the same size and mass as the Moon, radioactive heating should play little or no role in the ongoing volcanism there.

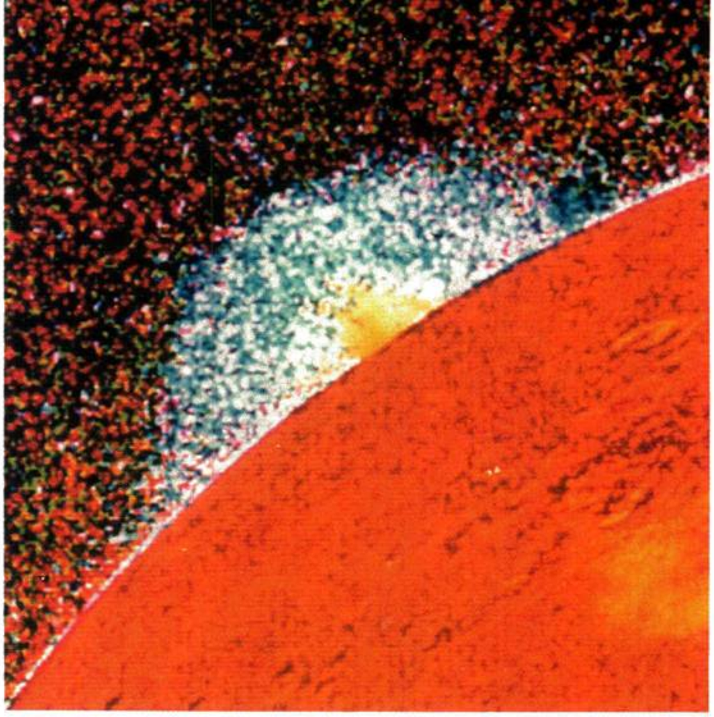
The second method of internal heating — tidal heating induced by a neighboring body — is the one at work in Io. This theory was first proposed for Io by Stanton Peale of the University of California at Santa Barbara and his colleagues and published just three days before the Voyager 1 encounter with Jupiter. Jupiter's gravity raises a tidal bulge in the solid body of Io in the same way that the Moon produces ocean tides and a tidal bulge on Earth, and Earth





Brian McLeod

PELE RETURNED TO LIFE in March 1990 after a decade of apparent silence. Pele's reawakening shows up in this ground-based contour plot (top) and infrared image (above) as a bright "hotspot" in the lower left corner of Io.



produces a tidal bulge on the Moon. And as with the Moon, tidal forces caused Io long ago to fall into synchronous rotation about Jupiter. This means Io rotates once on its axis every time it revolves once around Jupiter and thus always keeps the same face pointing toward Jupiter.

These tidal forces would produce no heating if Io's orbit around Jupiter were a perfect circle. But Io follows a slightly elliptical path, and when it is closest to Jupiter it travels slightly faster than average, and when it is farthest from Jupiter it travels slightly slower. Io keeps spinning on its axis at the same rate regardless of where it lies in its orbit, forcing its tidal bulge to wobble back and forth. Jupiter's gravity always works to pull Io's tidal bulge into a straight line with Jupiter. This causes constant flexing of Io's crust and generates Io's internal heat.

If Io and Jupiter existed alone in space, this action would eventually force Io's orbit into a perfect circle. But the inner three Galilean satellites orbit in resonance — each time Ganymede completes one orbit around Jupiter, Europa completes two and Io four. The periodic alignment keeps the elliptical orbit of Io from becoming circular and keeps the internal fires burning brightly.

Though tidal heating explains how Io generates so much volcanic activity, one troubling question remains. Detailed measurements made by Alfred McEwen of the U. S. Geological Survey and his colleagues show that the amount of heat flowing from Io during the Voyager 1 flyby is probably significantly greater than the average amount of tidal heating. Apparently Io either was anomalously active during the Voyager encounter or the amount of tidal heating varies with time.

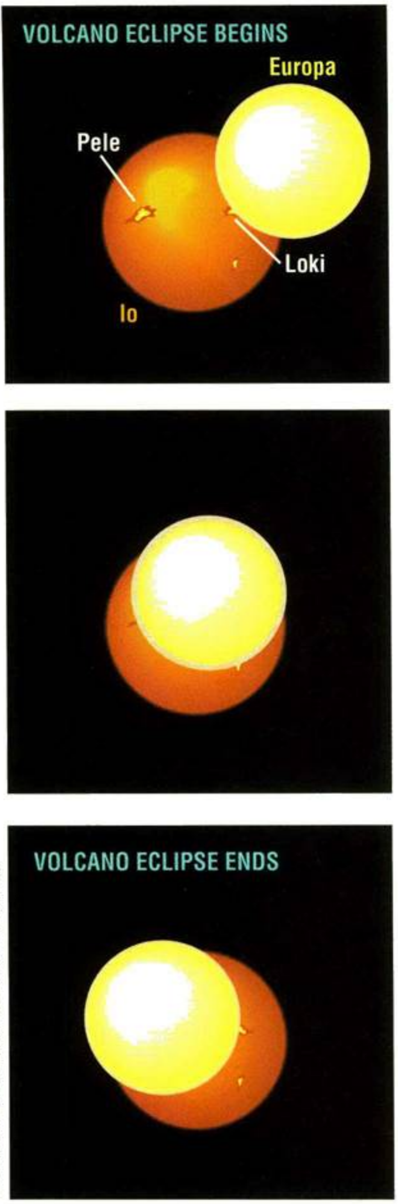
Seeing with Infrared Eyes

Once the Voyager spacecraft left Jupiter behind, astronomers were forced to observe Io from Earth. But could they learn anything of interest about Io? After all, the most striking aspect of Io is its volcanic activity, something most astronomers never even suspected from observations predating the Voyager flybys.

Two reasons explain why Earth-based studies now prove so useful in monitoring Io. First, astronomers know from the Voyager data that volcanos exist on Io and where they are located, which helps observers interpret what they see in the telescope. And second, infrared detectors have improved so much in the past decade that Earth-based telescopes can now resolve individual hotspots on Io's surface.

Infrared observations are the most useful because hotspots contribute most of the energy radiated by the satellite at infrared wavelengths. Though Io can be studied almost any time Jupiter is visible, the best time to observe it in the infrared is when it lies in Jupiter's shadow. During these eclipses, no sunlight reaches Io and thus no solar infrared radiation is reflected toward Earth to mask the volcanic hotspots. The main drawback to observing Io during eclipse is that its Jupiter-facing hemisphere always faces Earth at that time and the other side can't be seen.

Another good time to observe Io is while it is passing behind the limb of Jupiter. By measuring the brightness of the satellite over time, astronomers can discern when individual hotspots disappear behind Jupiter's limb. As with eclipses, however, these occultations permit researchers to view only the Jupiter-facing hemisphere. To see the other side of the satellite, they must observe when Io lies on the near side of Jupiter. A particularly good time to observe is when another Galilean satellite passes in front of Io,



ASTRONOMY: Thomas L. Hunt after P. Descamps

IO'S SISTER SATELLITE EUROPA passed in front of Io on February 20, 1991, slowly covering and uncovering hotspots associated with Io's volcanos (above). Carefully measuring Io's infrared brightness during this occultation revealed that the most active volcano at that time was Loki (below).

NASA/JPL

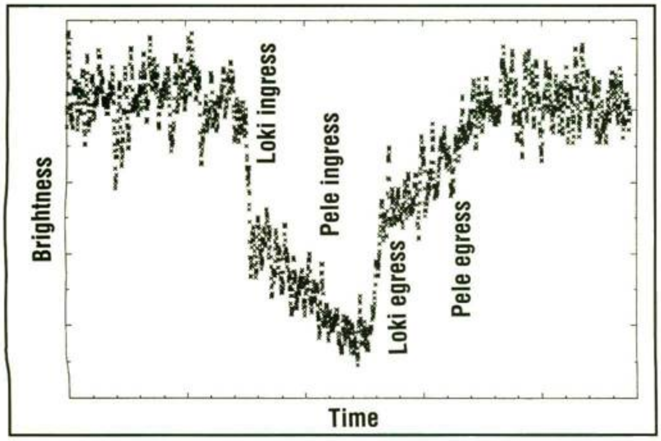
IO AND EUROPA HOVER ABOVE JUPITER — the trio of objects responsible for Io's volcanos. Tidal forces induced in Io by Jupiter stoke the satellite's internal fires, which are maintained because Europa keeps Io's orbit from becoming circular.

which happens several times during a roughly one-year period every six years (see "Watch Jupiter's Moons Play Tag" by John E. Westfall, January 1991).

Not only can infrared detectors resolve many of the hotspots detected by Voyager, they have even discovered a few not seen by Voyager. John Spencer of Lowell Observatory and his colleagues have been monitoring Io over the past several years using an infrared camera on the 3.2-meter NASA Infrared Telescope Facility on Mauna Kea in Hawaii. Observations they made in December 1989 when Jupiter eclipsed Io revealed a previously unknown hotspot. They dubbed the hotspot "Kanehekili" after a Hawaiian thunder god.

For the past several years, several groups (including Spencer's) have been following Loki, the largest hotspot on the Jupiter-facing hemisphere. Loki's brightness varies greatly — it was bright in late 1989 and early 1990, faint in spring and autumn 1990, bright again during the winter of 1990/1991, and faint between October 1991 and May 1992. Loki appeared 16 times brighter in December 1989 than it did in December 1991.

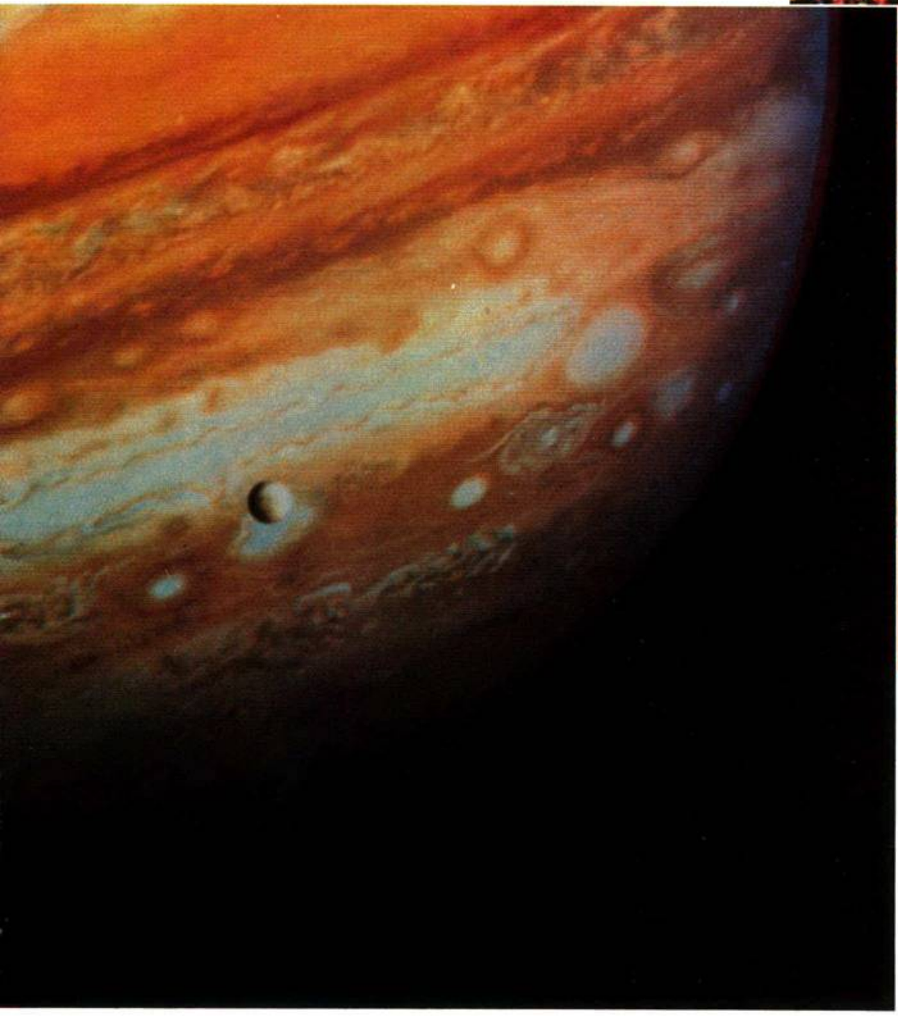
Loki appears significantly cooler when it is quiescent than when it is active. On January 24, 1991, during an active phase, Loki's temperature measured roughly 480 K. During a quiescent phase one year later, the hotspot's temperature dipped to about 355 K. The observations suggest that Loki's changes in brightness arise mostly from changes in temperature instead of changes in the area of the exposed volcanic materials.

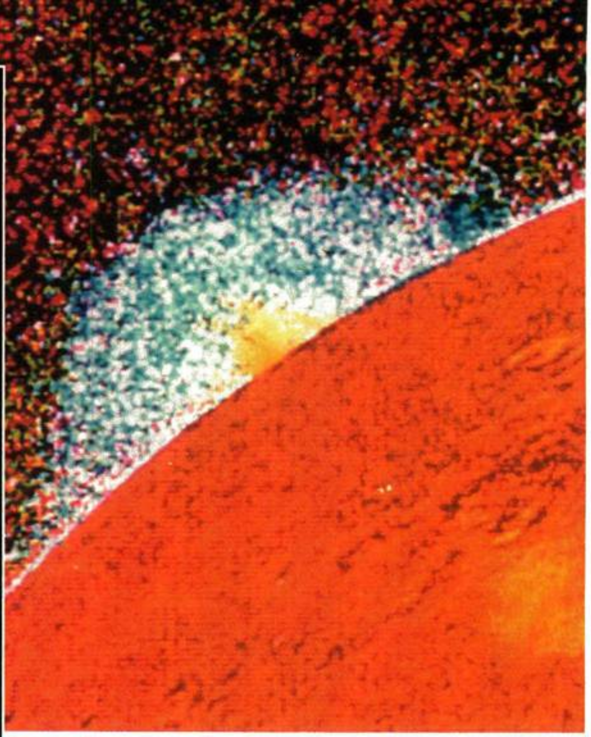


The Return of Pele

Only one volcano out-erupted Loki at the time of the Voyager 1 flyby — Pele. But Pele went quiescent after that, escaping notice when Voyager 2 flew by just four months later and apparently remaining dormant for over a decade. Even detailed observations of a 1985 occultation of Io by Callisto showed no sign of activity. But Pele was far from extinct.

Brian McLeod and his colleagues





at the University of Arizona's Steward Observatory systematically observed Io with the Multiple Mirror Telescope during November 1989 and March 1990. Using a high-resolution imaging technique called speckle interferometry, they viewed four different central meridians of Io to gain a view of the entire object. And on March 8, 1990, while observing the hemisphere that faces away from Jupiter, they detected Pele (see page 43).

The observations imply that Pele can erupt at decade-long intervals, though the lack of continuous coverage makes it impossible to say how long an individual eruption may last. Pele is particularly hard to observe from the ground because it always faces away from Earth during the prime observing times when Jupiter eclipses or occults Io.

In fact, very few ground-based observations of this hemisphere have ever been made except during the series of mutual events among the Galilean satellites. The last such series occurred between late 1990 and early 1992, and several groups of astronomers were ready.

Jay Goguen of the Jet Propulsion Laboratory and his colleagues observed Europa passing in front of Io eight times in early 1991. During a typical occultation, Europa travels about 10 km/s relative to Io. This means that measurements taken every few tenths of a second can resolve details as small as a few kilometers across on Io.

Goguen's team found both Loki and Pele active during that time and both varied significantly. Loki grew about 50 percent brighter during February alone, so astronomers got a bird's-eye view of the evolution of a major eruption. And on two occasions the researchers resolved Loki's "hotspot" into hotspots — two narrow fissures 20 to 30 km wide and about 100 km apart.

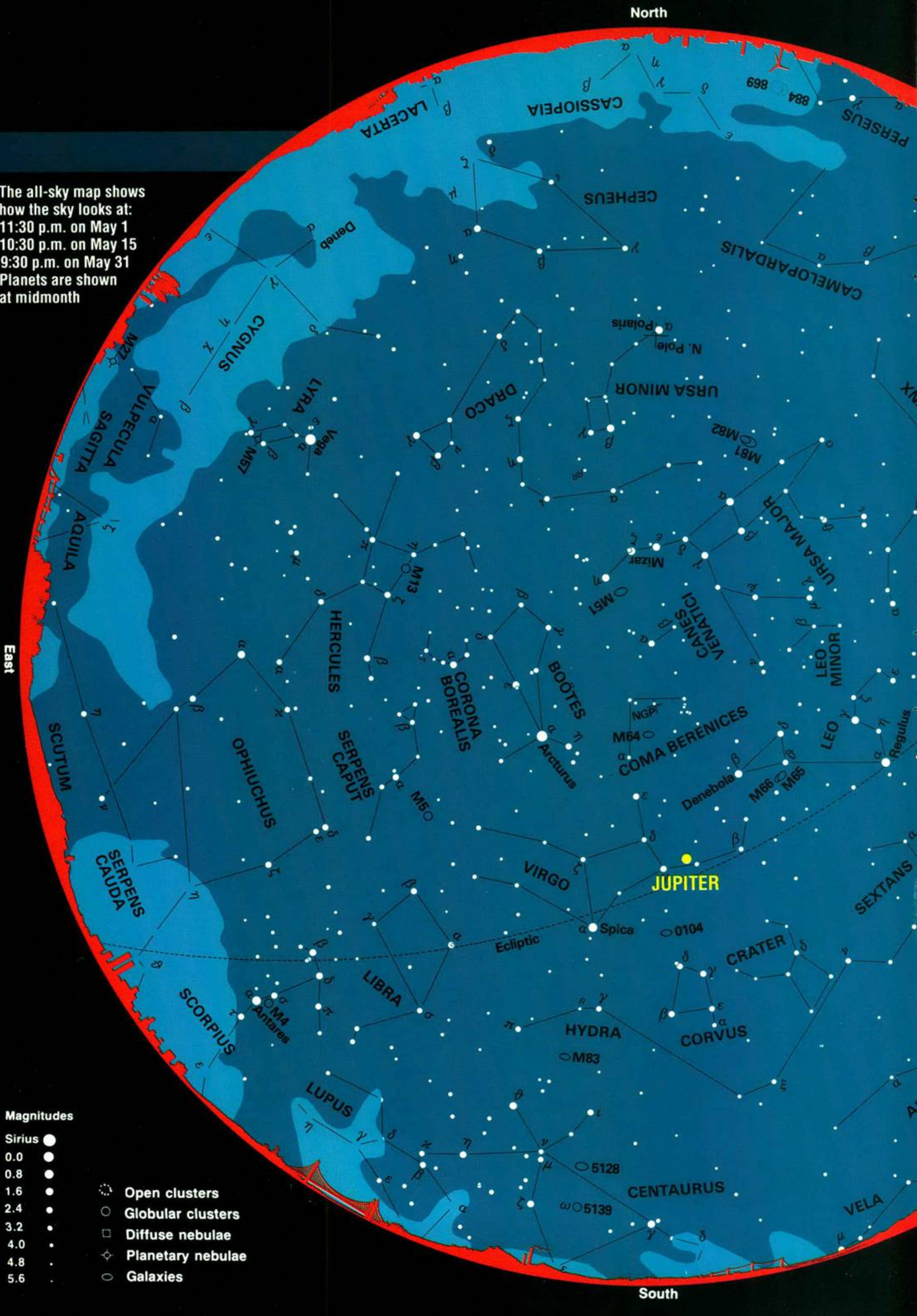
P. Descamps and his team from the Bureau des Longitudes in Paris, France, observed Europa occulting Io in February 1991. They also detected Loki and Pele, though Loki was much brighter. And Robert Howell and B. Uberuaga of the University of Wyoming observed several occultations, again showing both Loki and Pele, with Loki some ten times brighter. The mutual events confirmed that Pele was back, though at a much lower level than during the Voyager 1 flyby, and continued to show Loki as a long-lived, highly variable hotspot.

Twenty Times Closer

Though ground-based observations will continue to play an important role, they can't come close to matching the detail seen from a spacecraft. The Galileo orbiter is now well on its way to Jupiter and will arrive in about two-and-a-half years. On December 7, 1995, the spacecraft and its cargo of sophisticated instruments will hurtle past Io at a distance of only 1,000 km. This is some 20 times closer than Voyager 1's flyby distance and, with Galileo's advanced camera, should yield photos with resolutions 50 times better (about 20 meters). Over the succeeding two years, Galileo will monitor Io's volcanos from a few hundred thousand kilometers away.

No one knows what Galileo will find. After all, the intensity of the volcanos varies markedly and quickly, so astronomers may see a whole different set of active volcanos. And the surface itself could look surprisingly different than the surface seen by Voyager. After all, every year the volcanos deposit about another 10 cm of material on the satellite's surface, so more than a meter of new material should cover the Voyager-era surface. Though the Voyager encounters provided unparalleled drama as volcanos erupted before the spacecraft's electronic eyes, Galileo promises to far surpass its predecessors and help astronomers understand the inner workings of the strange world of Io. □

The all-sky map shows how the sky looks at:
11:30 p.m. on May 1
10:30 p.m. on May 15
9:30 p.m. on May 31
Planets are shown at midmonth


North
South
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CASSIOPEIA
LACERTA
PERSEUS
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CAMELOPARDALIS
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CYGNUS
M27
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LYRA
Vega
M57
DRACO
N. Pole
Polaris
URSA MINOR
M81
M82
AQUILA
M13
HERCULES
Mizar
URSA MAJOR
M51
CANES VENATICI
LEO MINOR
SCUTUM
OPHIUCHUS
SERPENS CAPUT
CORONA BOREALIS
BOÖTES
Arcturus
NGP
M64
COMA BERENICES
LEO
Regulus
Denebola
M66
M65
M5
SERPENS CAUDA
VIRGO
JUPITER
SEXTANS
Spica
0104
Ecliptic
CRATER
LIBRA
SCORPIUS
M4
Antares
HYDRA
CORVUS
M83
LUPUS
CENTAURUS
5128
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Magnitudes
Sirius
0.0
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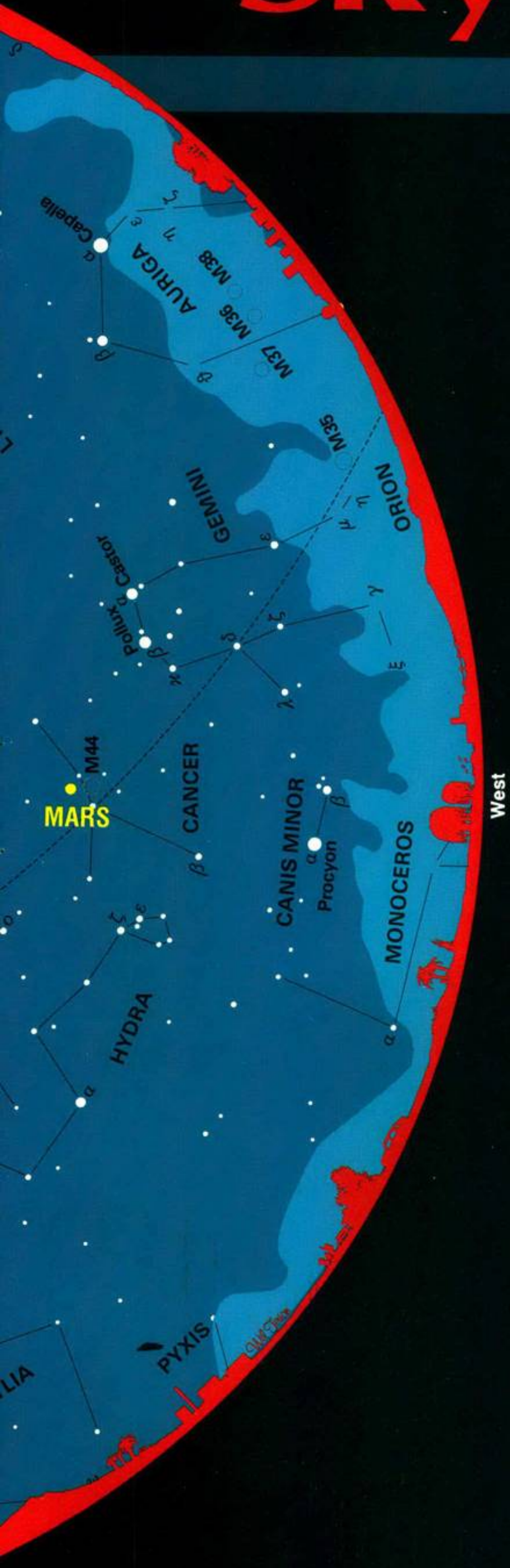
Open clusters
Globular clusters
Diffuse nebulae
Planetary nebulae
Galaxies

Sky Almanac

May 1993



SOLAR ECLIPSE ON MAY 21

Observers in the northern and western parts of North America can watch the Moon pass in front of the Sun on the morning of May 21. The best view occurs in the Pacific northwest, where about 40 percent of the Sun is covered by the Moon's disk right after sunrise, though anyone north and west of a line running from southwestern Texas northeast to Ohio can see the Moon take at least a small bite out of the Sun.

VENUS DOMINATES THE MORNING

The brilliant point of light hanging low in the eastern sky before dawn is none other than Earth's closest neighbor, Venus. On May 7, the planet shines at magnitude −4.5, the brightest it gets during this current morning apparition. A quick look at Venus through a telescope that day will reveal a 38"-diameter disk that is 26 percent illuminated.

SATURN ECLIPSES IAPETUS

On the morning of May 2, Saturn's outermost large satellite, Iapetus, passes through the shadow of the ringed planet for the first time in 15 years. Observers will need a good 6-inch telescope to follow the 11th-magnitude satellite as it progresses through the shadows cast by Saturn's disk and the planet's rings.

MARS AND THE BEEHIVE

One of the finest open star clusters in the sky — the Beehive cluster in Cancer — receives a visit from Mars this month. You can see the Red Planet skirt the northern regions of the Beehive on the evenings of May 11 and May 12.

Calendar of Events

2 Saturn eclipses Iapetus
3 The Moon passes 7° south of Jupiter, 11 a.m. EDT
The Moon is at perigee (225,370 miles from Earth), 8:13 p.m. EDT
4 Eta Aquarid meteor shower peaks
5 Full Moon is at 11:34 p.m. EDT
7 Venus is at greatest brilliancy (−4.5 magnitude)
11 Mars passes through M44
13 Last Quarter Moon is at 8:20 a.m. EDT
14 The Moon passes 7° north of Saturn, 3 a.m. EDT
Pluto is at opposition
15 The Moon is at apogee (251,598 miles from Earth), 5:47 p.m. EDT
Mercury is in superior conjunction
21 New Moon is at 10:06 a.m. EDT; partial solar eclipse
27 The Moon passes 7° south of Mars, 3 a.m. EDT
28 First Quarter Moon is at 2:21 p.m. EDT
30 The Moon passes 7° south of Jupiter, 5 p.m. EDT
31 The Moon is at perigee (228,515 miles from Earth), 7:11 a.m. EDT

Eye on the Sky by Deborah Byrd

THE MOON ECLIPSES THE SUN

On May 21 the New Moon passes between us and the Sun, partially blocking the Sun from view. This partial solar eclipse can be seen from a large area of the northern and western United States and Canada in the early morning, and from northern Europe in the afternoon. Observers in the United States and Canada will see up to about 50 percent of the Sun covered, with the greatest coverage coming for those living in the far northwest.

Before viewing any solar eclipse, remember the great danger in looking directly at the Sun! Even a tiny sliver of the Sun's surface is bright enough to permanently damage your eyes. Don't risk them by using sunglasses, smoked glass, or other unsafe methods.

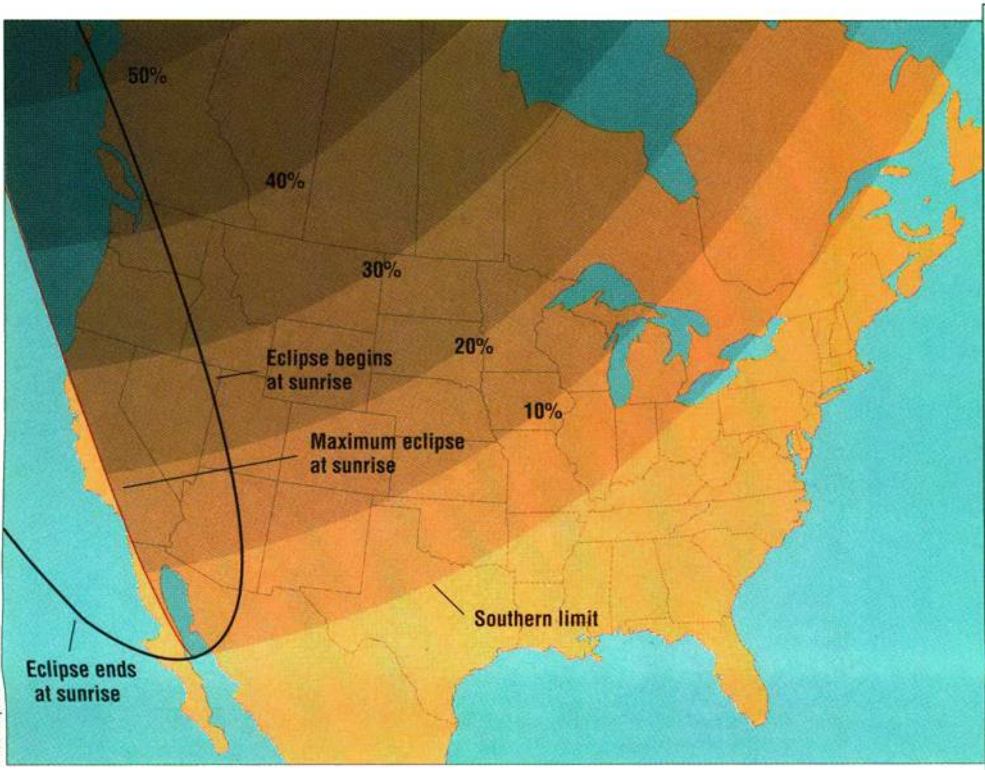
We recommend three techniques. One is to view the eclipse through an aluminized Mylar solar filter, the kind available from reputable dealers of astronomical equipment. Another is to use a piece of #14 welder's glass. This will filter out all the dangerous infrared and ultraviolet radiation and cut down the visible light by a factor of about 370,000. You can usually find welder's glass at suppliers listed in the Yellow Pages under "welding supplies."

A third method is to create an indirect viewing system by projecting the Sun's image through a pinhole in cardboard. You probably won't see any details on the Sun with this method, but you will be able to see how much of the Sun the Moon blots out. This can be a memorable way to view an eclipse. I can recall my father doing this when I was a child. Just hold the cardboard with the pinhole roughly perpendicular to the Sun's rays. Let the image of the Sun fall on a white surface, perhaps another piece of cardboard covered with white paper. You can vary the distance between the pieces of cardboard until you get the best image.

As you gaze at the eclipse, also look around at some of the natural phenomena on the ground and in the sky. Look on the ground underneath a tree for images of the partially eclipsed Sun. The spaces between the leaves serve as natural pinholes, creating the images. If there's a

Ernest Piini

A STRANGE SUNRISE BECKONS people along the west coast on May 21. Up to half the Sun will be covered by the Moon's disk as it pokes above the horizon that morning, stirring memories of the December 13, 1974 eclipse (above). Many other parts of the United States and Canada will see a partial eclipse later that morning (below).

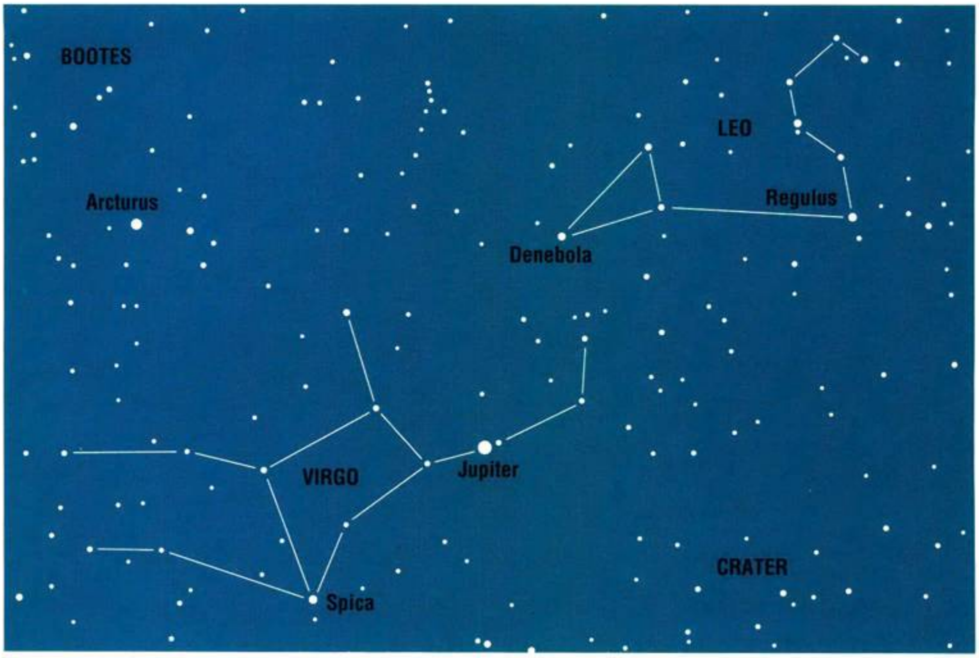


Fred Espenak

MAXIMUMS OF SOLAR ECLIPSE

City	Local Time	Percent Covered
Calgary	7:14 a.m.	40
Chicago	7:57 a.m.	6
Denver	6:53 a.m.	17
Des Moines	7:55 a.m.	11
Detroit	8:59 a.m.	2
Edmonton	7:18 a.m.	43
El Paso	6:42 a.m.	4
Kansas City	7:51 a.m.	7
Los Angeles	5:50 a.m.	17
Milwaukee	7:59 a.m.	8
Minneapolis	8:02 a.m.	16
Phoenix	5:47 a.m.	12
Portland	7:08 a.m.	38
Salt Lake City	6:57 a.m.	24
San Diego	5:48 a.m.	14
San Francisco	5:57 a.m.	27
Seattle	6:11 a.m.	41
St. Louis	7:50 a.m.	2
Toronto	9:03 a.m.	1
Vancouver	6:14 a.m.	43
Victoria	6:13 a.m.	43
Winnipeg	8:10 a.m.	27

breeze, the little Sun-pictures beneath the trees will dance in the grass.



JUPITER RIDES HIGH in the south on May evenings, shining at magnitude –2.3 halfway between 1st-magnitude Spica in Virgo and 2nd-magnitude Denebola in Leo.

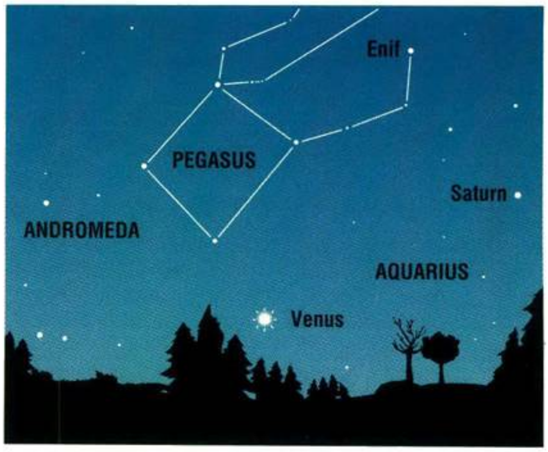
VENUS AT ITS BRIGHTEST

Venus shone like a beacon in the southwest after sunset when the year began. On April 1, it passed between the Sun and Earth and shortly afterward reappeared in the predawn sky. Now Venus reaches a milestone for this morning apparition. The planet appears at greatest brilliancy on May 7, when it shines at magnitude –4.5. Venus appears brilliant throughout May, however, shining low in the east before dawn.

Greatest brilliancy arises from a combination of the planet's apparent size and illumination. The disk of Venus — visible only with optical aid — always appears largest when Venus is closest to Earth. When the planet passed between us and the Sun on April 1, its disk measured nearly 1 arcminute across. But Venus never appears brightest when it lies between us and the Sun. It can't, because its lit hemisphere then faces away from us.

Greatest brilliancy stems not only from the apparent size of the planet's disk, but also from the fraction of the planet's lighted half visible to us. Since early April, Venus has been speeding ahead of us in its smaller orbit around the Sun and the distance between our two worlds has been increasing. On May 7, Venus shines across a distance of about 40 million miles, some 50 percent farther than in early April. As a result, the planet appears only two-thirds as large now as it did a month ago. But Venus is brighter now because a larger fraction — 26 percent — of its lit half faces in our direction. The competition between size and illumination reaches its peak on May 7, and Venus shines most brightly.

With Venus so bright this month, you might try looking for it during daylight. A good time to look is on the morning of May 17 or 18 when the planet lies near the waning crescent Moon. Just locate the pair in the east before dawn and follow them through sunrise.



BLAZING THROUGH the morning twilight, –4.5-magnitude Venus overwhelms the nearby stars of Pegasus in the eastern predawn sky.

MAY'S PLANETS

Mars lies high in the west when darkness falls and sets shortly after midnight. Though the Red Planet is conspicuously dimmer now than it was in early 1993, at magnitude 1.2 it is still quite prominent. At the beginning of May it appears near Castor and Pollux, the two brightest stars in the constellation Gemini, but it is actually just over the (invisible) border into Cancer. As it edges eastward this month, Mars passes through Cancer's famous Beehive star cluster. Under a dark sky, you can spot this cluster with the naked eye. Binoculars will enhance your view of the ruddy planet contrasting with the cluster's stars. Start watching early in the month; the best part of the show comes on May 11 and 12.

Another, much brighter planet is also up in the evening sky. **Jupiter** appears as a bold, cream-colored object lying almost due south as twilight comes to a close. The giant planet shines brilliantly at magnitude –2.3 among the much fainter stars of Virgo. It stands nearly 20° from Virgo's brightest star, 1st-magnitude Spica.

The sixth planet from the Sun, **Saturn**, rises in the wee hours and appears in the southeast before dawn. It's not much to see with the naked eye, just a 0.9-magnitude golden "star" in the constellation Aquarius. Yet Saturn has a steady quality that makes it a continual pleasure to see in each year's sky. If you watch on the mornings of May 14, 15, and 16, you'll see the waning crescent Moon slide past Saturn in the predawn sky.

Venus shines with a brilliant, almost eerie light low in the eastern predawn sky. At greatest brilliancy on May 7, the planet is unmistakable to the naked eye at magnitude −4.5. But then again, it's always unmistakable! No other starlike object comes close to shining so brightly. Venus dims a bit after this, but it continues to climb higher in the predawn sky on its way to greatest elongation in June.

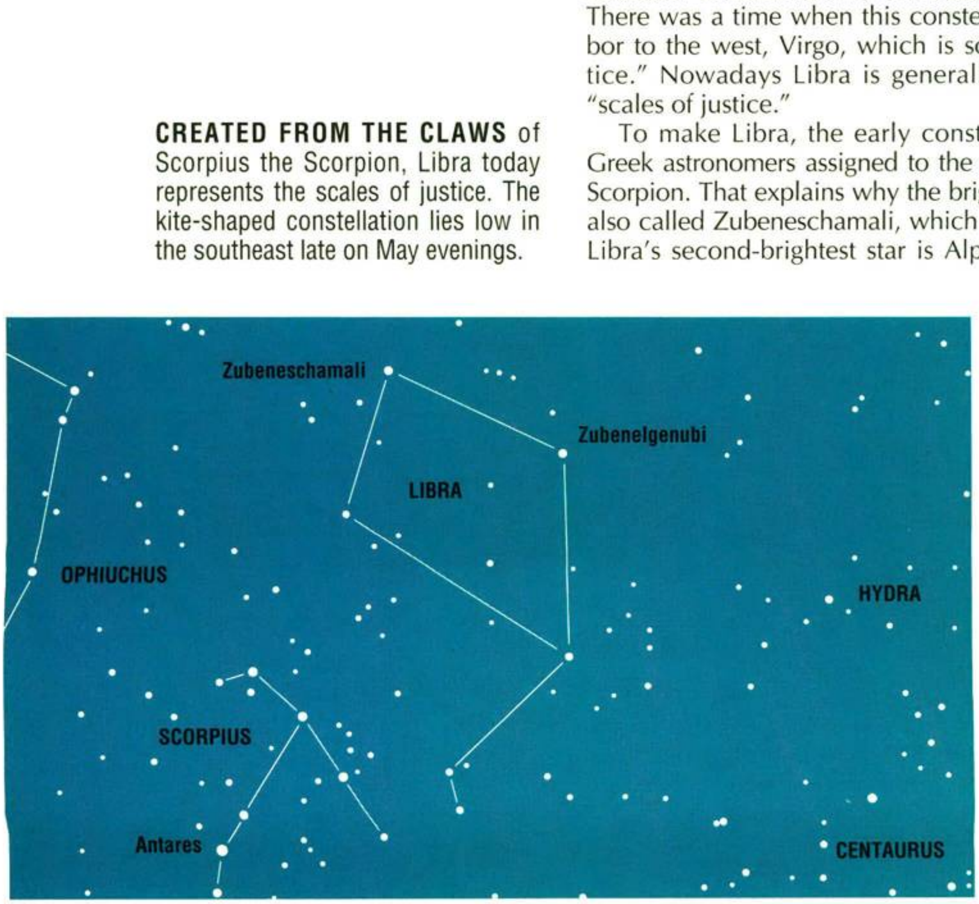
The innermost planet can't be seen this month. **Mercury** is traveling behind the Sun as seen from Earth, reaching superior conjunction on May 15/16. It will return for a favorable evening apparition in June.

THE STARRY SKY

The distant planet Pluto comes to opposition this month, but it is much too faint to see with the naked eye. (To find Pluto this month, see "Pluto Watch" on page 70.) Still, with only your unaided eye, you can come to know the planet's location in the sky. Pluto now lies within the boundaries of the constellation Libra the Scales.

Pluto is unique among the planets in our solar system for the peculiar shape and orientation of its orbit and for its small size and relatively large moon. Coincidentally, Libra is unique among the constellations of the zodiac. Of the twelve zodiacal constellations, only Libra is an inanimate object. Greek astronomers are credited with creating most of the zodiacal constellations, but Babylonian astronomers created Libra. There was a time when this constellation was associated with its neighbor to the west, Virgo, which is sometimes called the "goddess of justice." Nowadays Libra is generally considered to stand alone as the "scales of justice."

To make Libra, the early constellation-namers borrowed stars that Greek astronomers assigned to the constellation to the east, Scorpius the Scorpion. That explains why the brightest star in Libra — Beta Librae — is also called Zubeneschamali, which means "the northern claw" in Arabic. Libra's second-brightest star is Alpha Librae, or Zubenelgenubi, which means "the southern claw." If you look, you can imagine the Scorpion's claws stretching to these stars. In India, Alpha and Beta Librae were called the Gateway, because the Sun, Moon, and planets often passed between these stars — just as they sometimes still do today. But in its inclined orbit, Pluto doesn't make use of the Gateway, passing instead nearly 10° north of Zubeneschamali. You'll have to wait until late November to see the Gateway in action, when both Mercury and Venus pass through. □



CREATED FROM THE CLAWS of Scorpius the Scorpion, Libra today represents the scales of justice. The kite-shaped constellation lies low in the southeast late on May evenings.

Deborah Byrd writes and produces the daily "Earth and Sky" radio series. It can now be heard on over 200 stations.

Through the Eyepiece

by Jeff Kanipe

A PARTIAL SOLAR ECLIPSE

If you live in northern or western North America, you won't want to miss the May 21 partial solar eclipse. Although the Moon obscures only part of the Sun, the steady progression of the event is fascinating to observe in a telescope or record with a camera. And because the event occurs during or shortly after sunrise in many locales, you'll have plenty of opportunity to take aesthetic photographs of the eclipsed Sun near the horizon.

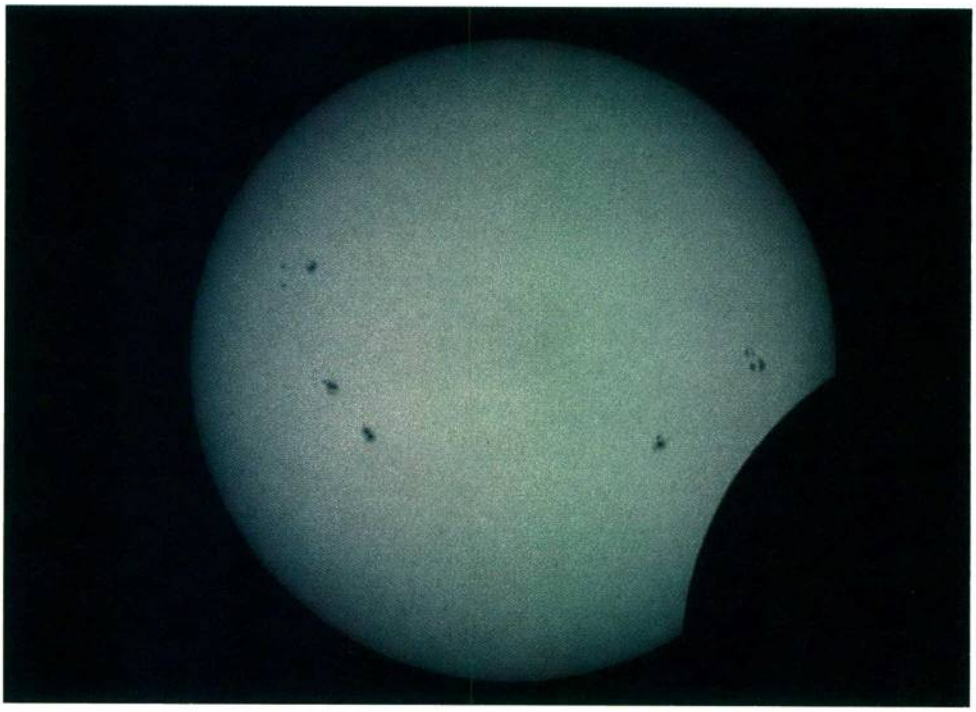
In the United States, your best view comes from the northwestern part of the country, where 30 to a bit over 40 percent of the Sun disappears at maximum eclipse. This takes place just after 6 a.m. local daylight time, with the Sun about 5° above the east-northeastern horizon. Less of the Sun is covered as you go farther south and east. (See page 48 for a map showing how much you will see.)

If you have a small telescope, you should have no trouble seeing the Moon nibble at the Sun. Of course, to do so safely you need proper eye protection. NEVER view the Sun directly with optical aid unless you use an over-the-aperture filter, such as an aluminized Mylar or glass filter. And always cap the finderscope's objective lens so the Sun's intense rays don't stream through and singe you.

Another safe method is to project the Sun's image from the telescope on to a screen of some sort, such as matte board or heavy cardboard. For a stable set up, mount the screen on a stand such as an easel, tiltable drafting table, or step ladder.

Projecting the Sun doesn't require a large telescope. In fact, it's best to use a telescope in the 3- or 4-inch class. If you use a bigger scope, mount an off-axis mask: You don't need all that aperture to project the Sun and don't want the heat that comes with it. (Warning: Don't project the Sun's image with a Schmidt-Cassegrain or other catadioptric because heat can build up rapidly in the enclosed tube and damage your scope. Use an aperture filter instead.) No matter what size telescope you use, occasionally cover the entire aperture for a couple of minutes to let the telescope cool down. This prevents your telescope from radiating excess heat and becoming its own source of bad seeing.

Because the idea is to view the whole solar disk, use low magnification — in the 30x to 40x range. (A low-cost eyepiece such as a 40mm Huygens or Kellner is your best bet because you won't mind terribly if the Sun's heat damages the optics.) The screen should be mounted so that the projected image has a diameter of about 6 to 8 inches. If possible, shade the screen to prevent the Sun's glare from competing with the image. With a setup like this, you should be able to watch the edge of the Moon as it covers and uncovers sunspot groups. Also see how soon after first contact — the instant at which the Moon's disk lies tangent to the Sun's disk — you can see a bite taken out of the Sun.



H. J. P. Arnold

WATCHING THE MOON slowly cover and uncover sunspots proves fascinating for eclipse watchers equipped with a small telescope and an over-the-aperture solar filter. On May 21, much of the United States will witness a partial eclipse similar to the July 11, 1991 eclipse shown here.

IAPETUS SLIPS INTO SATURN'S SHADOW

In the hours before dawn on May 2, Saturn's most distant large satellite, Iapetus, passes through the shadow of the great ringed planet. Don't miss this exceedingly rare event. Though two such eclipses occur this year (the second one comes on July 20/21), the next one doesn't come until 2008. Because Iapetus' orbit is inclined 15° to Saturn's orbital plane, these eclipses can occur only when the satellite lies near one of the nodes of its orbit (just as lunar and solar eclipses seen from Earth happen only when the Moon lies near a node of its orbit). That happens twice each Saturnian orbit, or once every 15 years.

Unfortunately, no one will see the entire event — it lasts too long. Because of its long period, Iapetus moves slowly with respect to Saturn. It takes the satellite some 19 hours to pass completely through the shadow of the rings and planet. And Saturn rises only a few hours before dawn, limiting your window on the event. The good news is that nearly everyone in the world can view at least some of the eclipse.

The universal times for every stage of the eclipse are given in the table at right. (Subtract 4 hours to convert to EDT, 5 hours for CDT, 6 hours for MDT, and 7 hours for PDT.) Keep in mind that the times are only approximate — astronomers don't know the precise orbit of Iapetus and some predictions yield times 20 to 30 minutes later than those quoted. That's the reason many professional astronomers will time this event — to help pin down Iapetus' orbit.

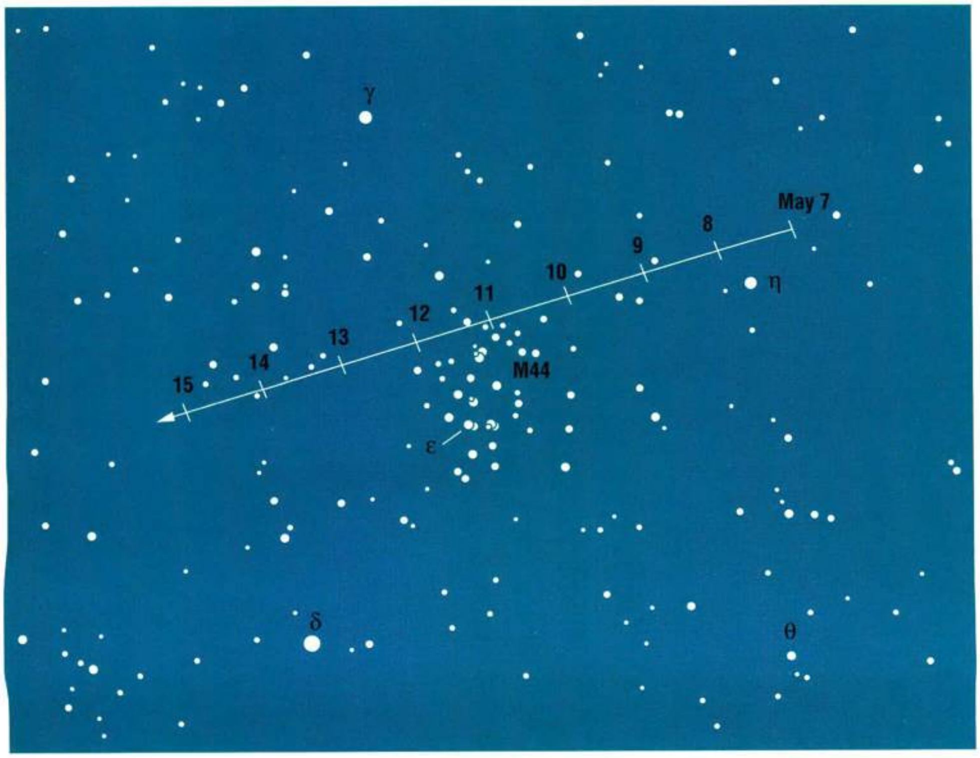
North American observers have the best view of the latter stages of the eclipse. Iapetus' dramatic emergence from the shadow of Saturn's disk occurs at 10h02m UT and should be seen from much of the continent. Thereafter, the impending dawn puts subsequent stages of the eclipse into a squeeze play. While easterners pack up their telescopes, those farther west can watch the satellite traverse the shadow of the inner C, or crepe, ring before disappearing into the B ring's shadow at 10h28m UT. Later, only observers in the Mountain and Pacific time zones can observe Iapetus emerging from the B ring's shadow at 12h19m UT and traversing the Cassini division that separates the B ring from the outer A ring. Finally, observers in Hawaii, who missed out on the previous stages, can look for Iapetus' emergence from the A ring's shadow at 13h43m UT.

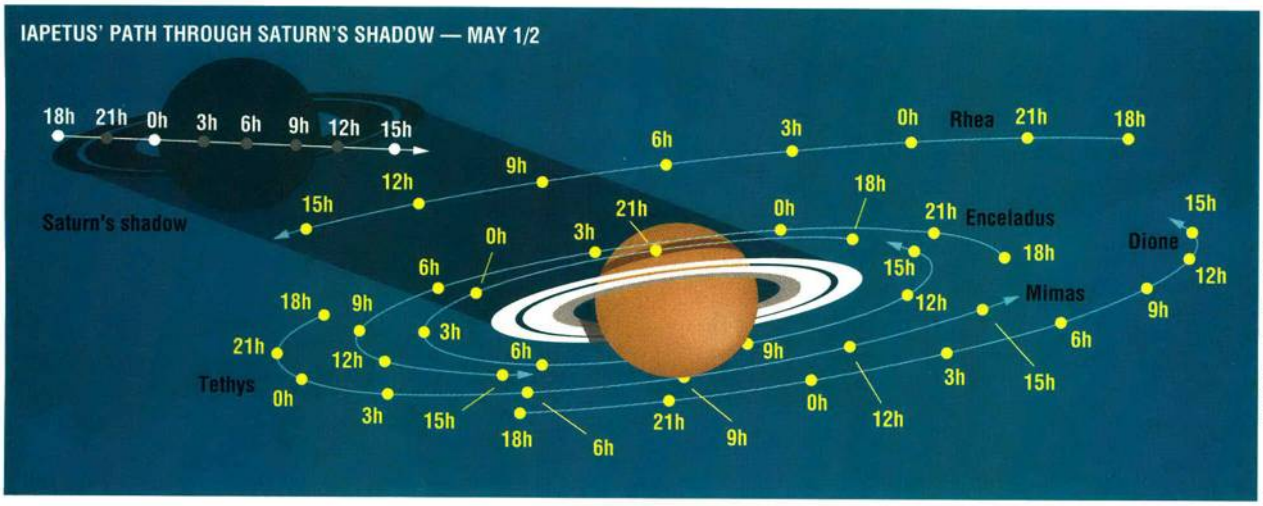
Observers should notice Iapetus' brightness fluctuate as it passes through the shadows of rings with different densities. Astronomers predict the satellite will dim to magnitude 11.7 as it moves through the C ring's shadow, then vanish entirely in the B ring's shadow, brighten to magnitude 12.1 in Cassini's division, and dim again to between 13th and 14th magnitude in the A ring's shadow. Your main objective, unless you own a photoelectric photometer, is to observe Iapetus emerging from Saturn's shadow and to monitor it thereafter for as long as you can.

Use the highest magnification

Donald C. Parker

SYRTIS MAJOR DOMINATES a CCD image of Mars taken on December 8, 1992 (above). You can catch the Red Planet passing through the Beehive on the evenings of May 11 and 12 (below; positions are shown for midnight EDT).





IAPETUS' PATH THROUGH SATURN'S SHADOW — MAY 1/2

ASTRONOMY: Phil Kirchmeier after M. Sôma

WATCH SATURN ECLIPSE IAPETUS on the morning of May 2, when the planet's disk and rings intermittently prevent light from reaching the 11th-magnitude satellite. South is shown at top and east at right to match the view in an inverting telescope. Times given are universal times beginning on May 1 and extending into May 2 (subtract 4 hours to convert to EDT, 5 hours for CDT, 6 hours for MDT, and 7 hours for PDT).

that the seeing allows to observe this event. As you look at the ringed planet, the eclipse takes place about 45", or a bit over one ring diameter, southwest of Saturn's center. Iapetus shines at 11th magnitude when not in eclipse, within easy reach of a good 6-inch telescope. This places it a factor of ten fainter than Saturn's brightest satellite, 8.3-magnitude Titan, which lies some 3' west of Saturn but only about a magnitude fainter than Saturn's three other bright satellites — Tethys, Dione, and Rhea.

DON'T OVERLOOK THE OTHER PLANETS

Outermost **Pluto** reaches opposition on May 14, when it lies in northernmost Libra. See "Pluto Watch" on page 70 for detailed maps showing how to find this 13.7-magnitude speck of light.

Shifting to the opposite end of the brightness scale, **Venus** reaches greatest brilliancy (at magnitude −4.5) on the morning of May 7. Greatest brilliancy always occurs about five weeks after greatest eastern elongation and five weeks before greatest western elongation, when the planet's phase and distance from Earth combine to reflect the most light in our direction. Through a telescope at a magnification of about 180x, Venus' 38"-diameter disk shows a decided crescent phase tilted toward the eastern horizon.

Other than its phase, Venus exhibits little detail. You might try using a neutral density filter to reduce the glare or observing the planet when thin clouds intrude on the area. Perhaps the best strategy, though, is to follow the planet through dawn and observe it after sunrise. With Venus higher in the sky and the contrast between the planet and sky much lower, the phase becomes quite distinct and the definition markedly improves. Venus stands out sharply against the pale blue sky and looks more like a world than the windblown Japanese lantern it often resembles.

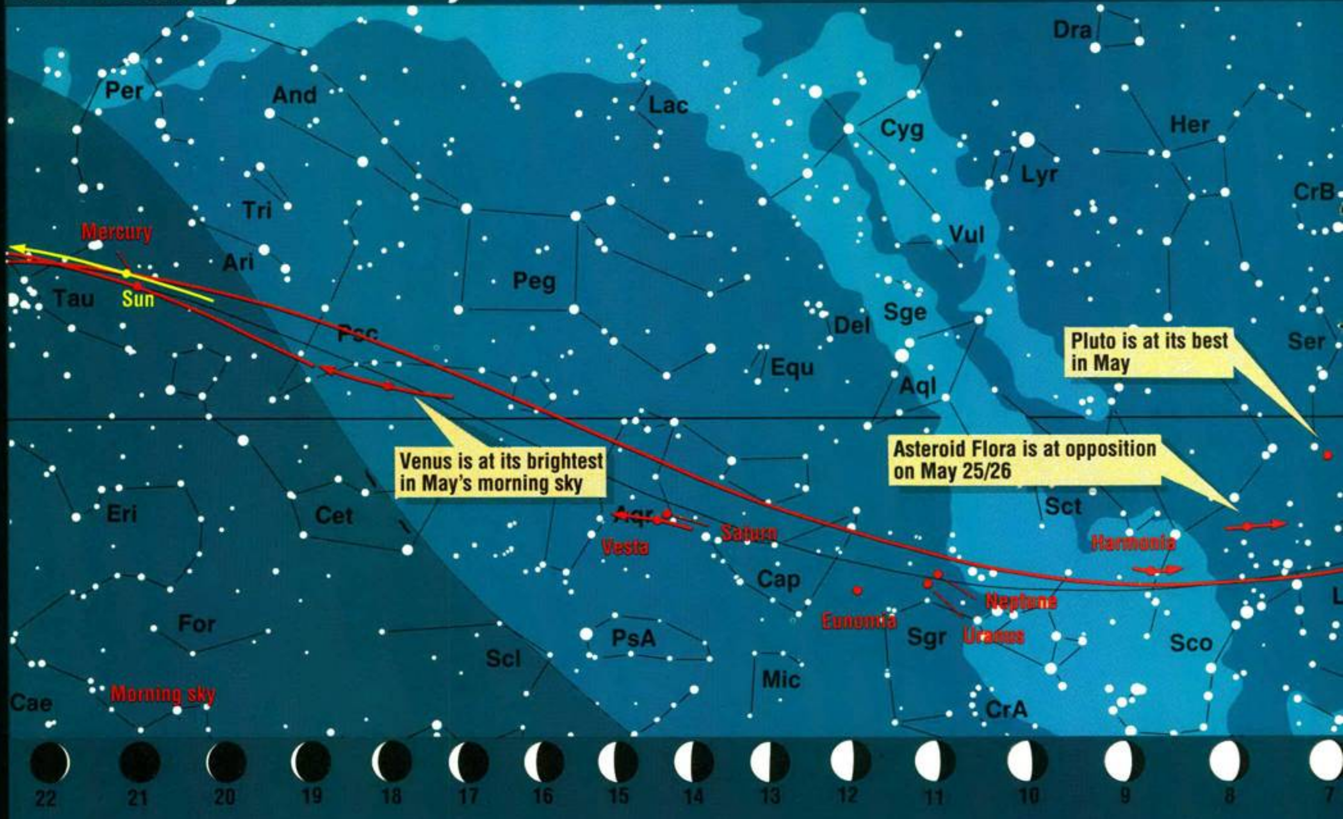
And a final observing note: **Mars** passes through the northern fringe of the Beehive cluster (M44) in Cancer on the evenings of May 11 and 12. It lies closest to the center of the cluster (about 15' away) just before it sets on May 12. The Red Planet also lies in the Beehive's vicinity on May 10 and 13. As you gaze at the ruddy intruder, keep in mind the scale of what you're seeing. Mars lies some 1.6 astronomical units, or 13 light-minutes, from Earth, a mere stone's throw compared with the Beehive, which lies more than a billion times farther away at a distance of 520 light-years. □

IAPETUS IN SATURN'S SHADOW

Phenomena	Time
May 1	
Enters A Ring shadow	18h27m
Leaves A Ring shadow	19h30m
Enters B Ring shadow	19h51m
Enters C Ring shadow	21h42m
Leaves C Ring shadow	23h00m
Enters Saturn's shadow	23h59m
May 2	
Leaves Saturn's shadow	10h02m
Leaves C Ring shadow	10h28m
Leaves B Ring shadow	12h19m
Enters A Ring shadow	12h40m
Leaves A Ring shadow	13h43m

Jeff Kanipe is the editor of Star Date *magazine, which is published by McDonald Observatory at the University of Texas at Austin.*

The Solar System   May 1993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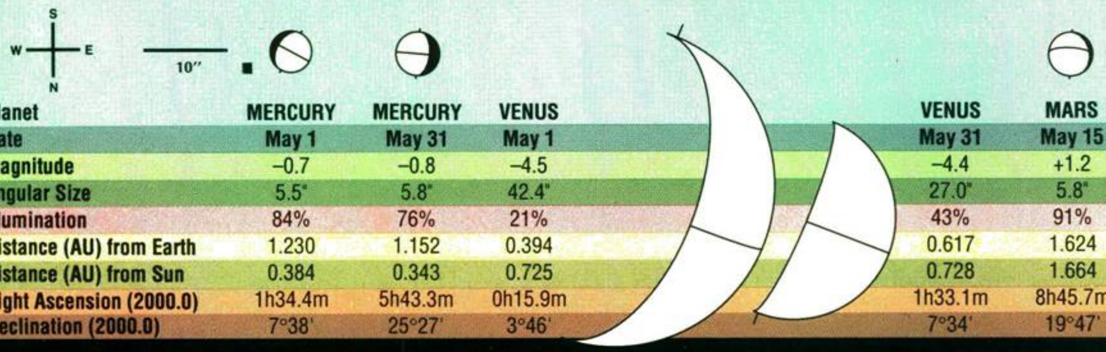
Pluto is at its best in May

Venus is at its brightest in May's morning sky

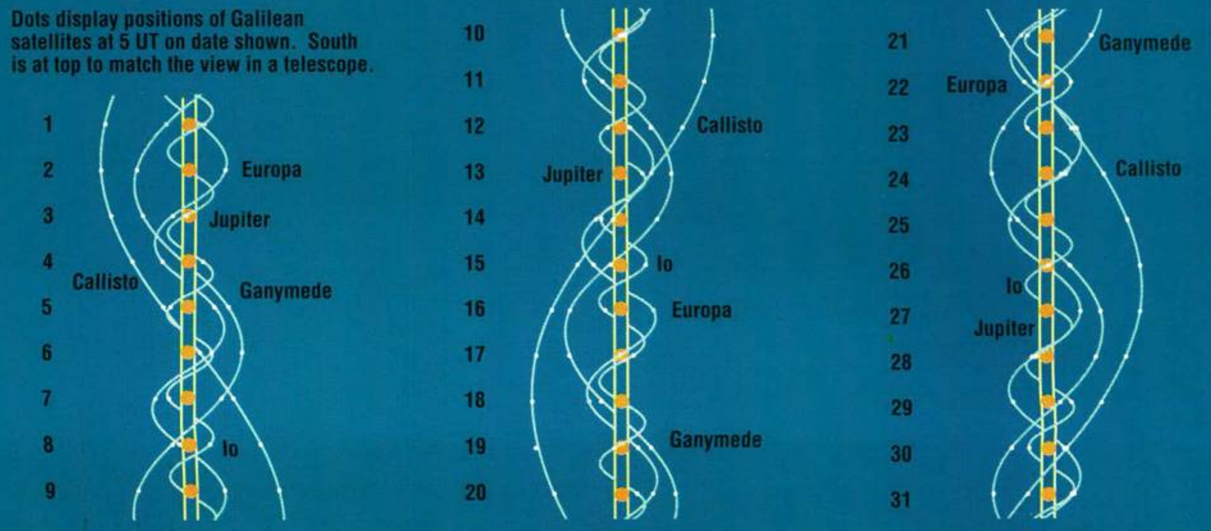
Asteroid Flora is at opposition on May 25/26

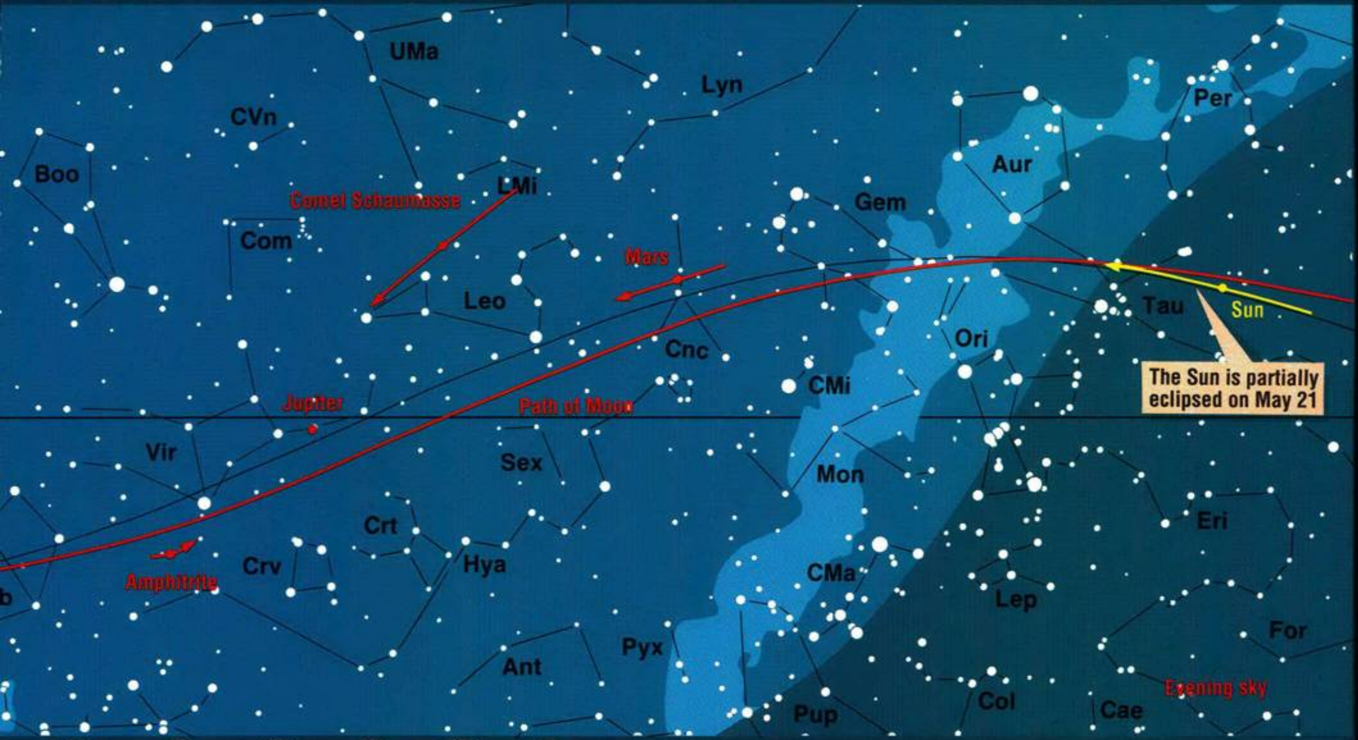


Planet	MERCURY	MERCURY	VENUS	VENUS	MARS
Date	May 1	May 31	May 1	May 31	May 15
Magnitude	–0.7	–0.8	–4.5	–4.4	+1.2
Angular Size	5.5″	5.8″	42.4″	27.0″	5.8″
Illumination	84%	76%	21%	43%	91%
Distance (AU) from Earth	1.230	1.152	0.394	0.617	1.624
Distance (AU) from Sun	0.384	0.343	0.725	0.728	1.664
Right Ascension (2000.0)	1h34.4m	5h43.3m	0h15.9m	1h33.1m	8h45.7m
Declination (2000.0)	7°38′	25°27′	3°46′	7°34′	19°47′

Jupiter's Moons

Dots display positions of Galilean satellites at 5 UT on date shown. South is at top to match the view in a telescope.

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Evening sky
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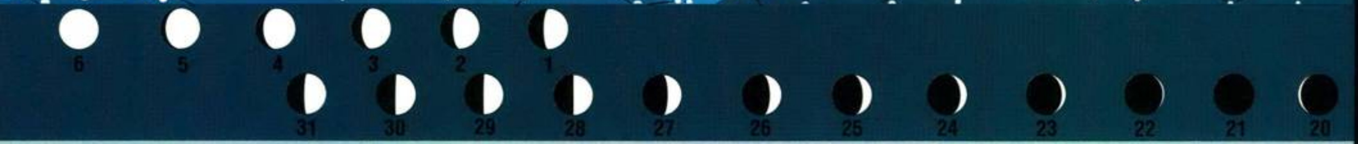
The Sun is partially eclipsed on May 21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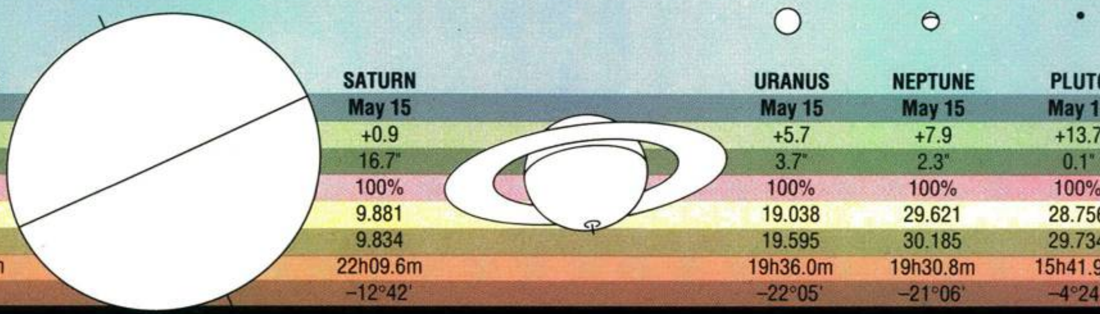
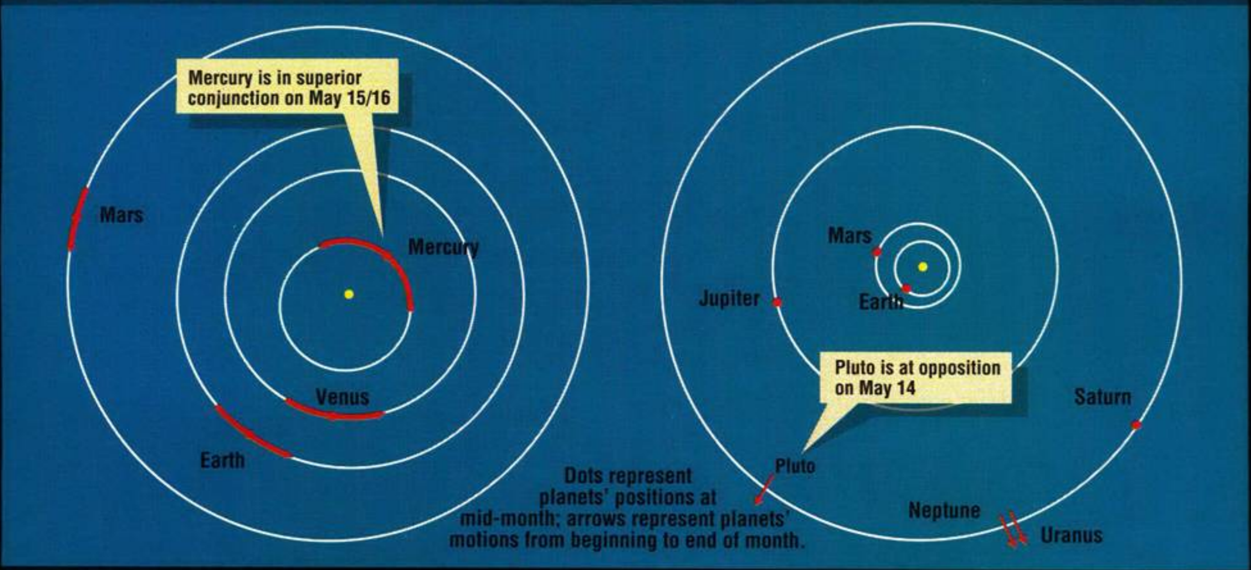


JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
May 15	May 15	May 15	May 15	May 15
−2.3	+0.9	+5.7	+7.9	+13.7
41.6"	16.7"	3.7"	2.3"	0.1"
100%	100%	100%	100%	100%
4.737	9.881	19.038	29.621	28.756
5.454	9.834	19.595	30.185	29.734
12h21.8m	22h09.6m	19h36.0m	19h30.8m	15h41.9m
−0°43'	−12°42'	−22°05'	−21°06'	−4°24'

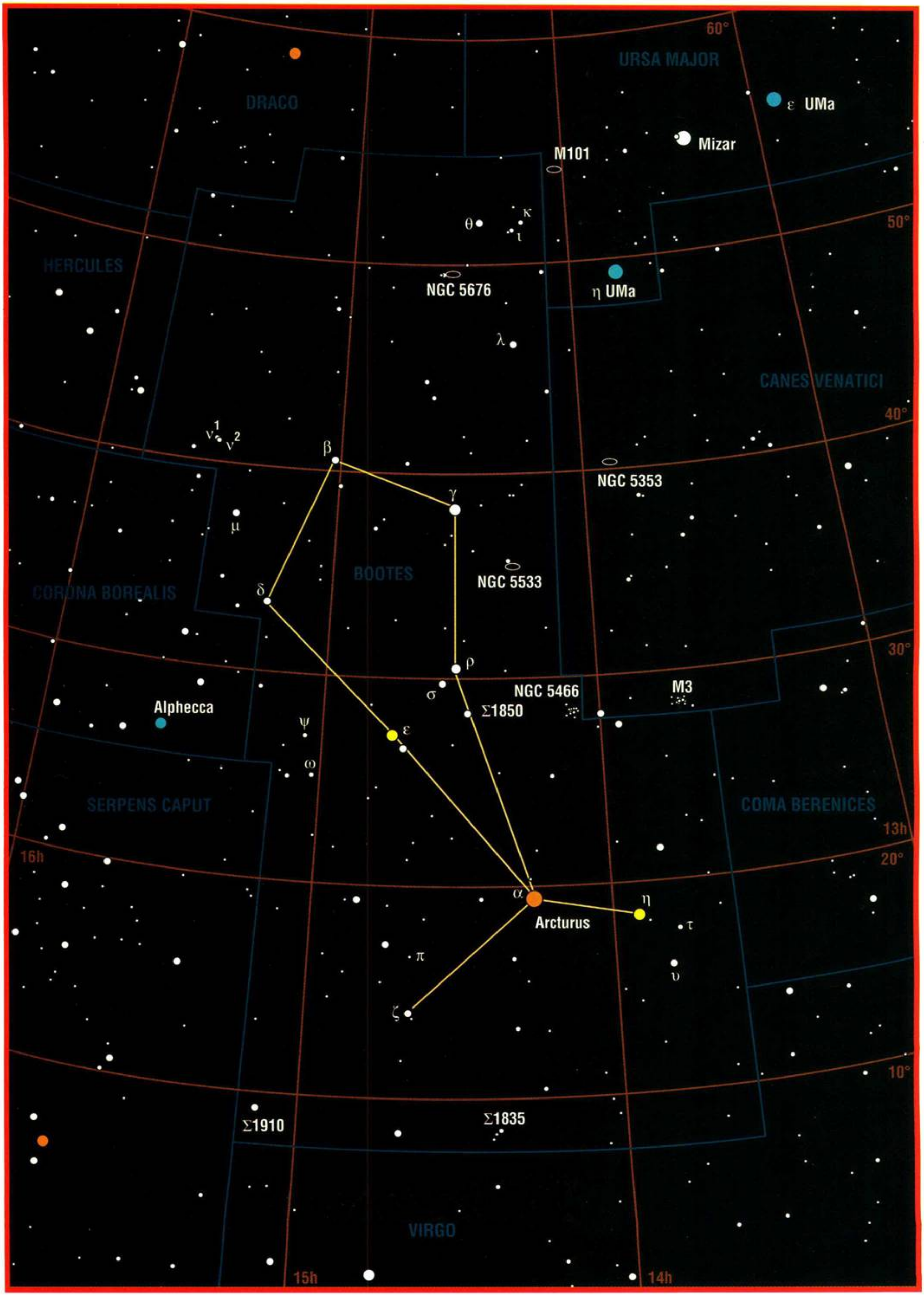
The Planets in Their Orbits


Mars
Mercury
Venus
Earth
Mars
Jupiter
Earth
Saturn
Pluto
Neptune
Uranus

Mercury is in superior conjunction on May 15/16

Pluto is at opposition on May 14

Dots represent planets' positions at mid-month; arrows represent planets' motions from beginning to end of month.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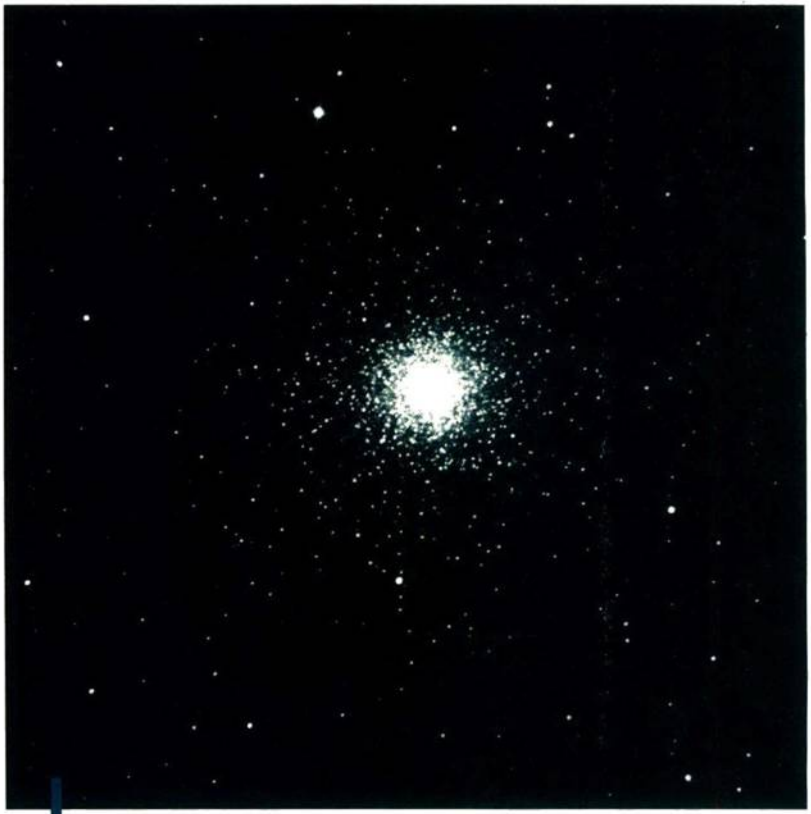
BOOTES
NGC 5533
CORONA BOREALIS
δ
30°
ρ
σ
NGC 5466
M3
Σ1850
Alphecca
ψ
ε
ω
SERPENS CAPUT
COMA BERENICES
13h
16h
20°
α
η
Arcturus
τ
π
υ
ζ
10°
Σ1910
Σ1835
VIRGO
15h
14h

BEAUTIFUL BOOTES

Explore Bootes, the prominent kite-shaped constellation. There you'll find colorful doubles, star clusters, and elusive galaxies.

by Alister Ling



M3

Mag.: 6.4
Size: 16.2'
by Preston Scott Justis

Sparkling orange Arcturus heralds the return of spring as it rises in the late night winter sky. If you own a telescope, Bootes the Herdsman offers you a fine evening of observing. Take a moment to appreciate the naked-eye view of this fine constellation while your telescope cools down in the crisp night air. The distinctive kite shape most of us know looks like an ice cream cone to other observers. To me, it has always been a perfect capital "Y." After a year or two of confusion, I realized that the top left star of the Y belonged to Corona Borealis. Fifteen years later, I still recognize the Y-shape first.

Bootes spans an amazing 45° of sky, with its northern extremity tucked next to the handle end of the Big Dipper. Despite this gentle giant's size, no bright Messier object lives within its realm. Fired with a little imagination, we can mentally redraw the constellation boundaries to the west to include the impressive globular star cluster M3 in Canes Venatici and M101 in Ursa Major.

Now that your telescope's hot air tube currents have quieted down, set your sights on Arcturus itself. It edges past Vega for the honor of brightest star in the northern sky — by a mere 0.07 magnitude. What color do you see? My first impression was peach. In a sad moment I realized that it was the perfect color match to the high-pressure sodium streetlight shining into my backyard.

The second brightest star in Bootes, the center of the Y, is one of the sky's best double stars. **Epsilon Bootis** carries two other names, Izar and the more familiar Pulcherrima. In 1829 the great double-star observer Otto Struve gave Epsilon this poetical Latin name meaning "the most beautiful one."

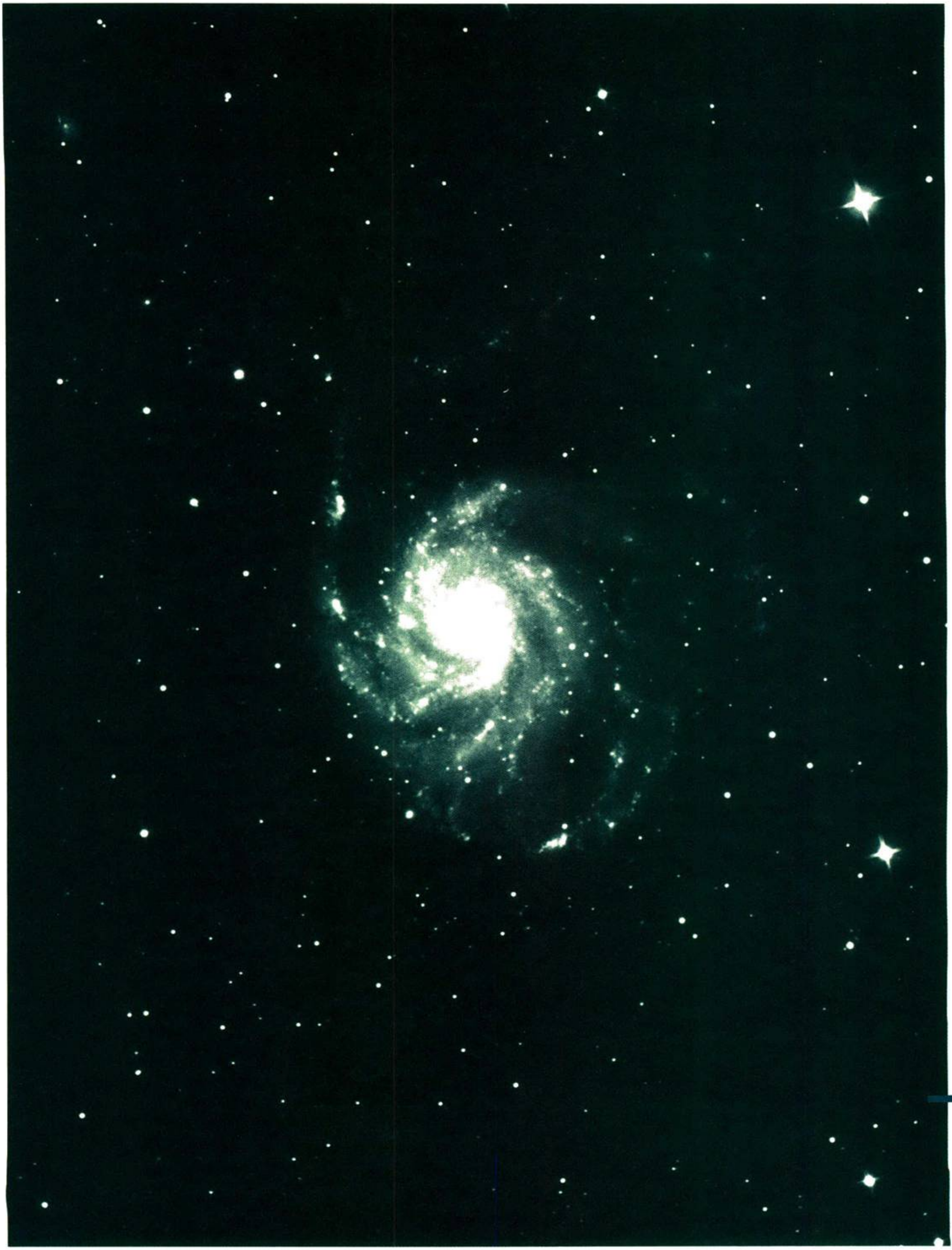
Pulcherrima is a striking pair consisting of a pale orange 2.5-magnitude star and a 4.9-magnitude companion a reachable 3" away. To put this separation into perspective, seek out the famous double star Mizar in the Big Dipper's handle. This close pair is an easy 14" apart.

The color of Pulcherrima's secondary is practically yours to choose. At low power, I thought I saw a tinge of blue. But at 215x it seemed more greenish. *Burnham's Celestial Handbook* calls it blue-green. A neat idea to try at your next star night is to observe Pulcherrima through a variety of telescopes and magnifications to see if your impressions of the colors change.

Just 3° west and a bit north is **Σ1850**. Sitting in an almost blank field, this nearly equal whitish pair is easy to split, with a separation of 25". If you're dark adapted and ready for a delight, swing your telescope westward by 45 minutes of right ascension into Canes Venatici. A low-power eyepiece will show you the bright globular cluster **M3** (NGC 5272). This object consists of hundreds of thousands of stars. M3's high surface brightness can drill through the most light-polluted sky.

Whenever you can, try high magnifications on deep-sky objects. This is the best way to see detail in them. It may take you some time to get used to the darker fields of view, but the rewards are well worth the effort. At 36x, I saw no sign of stars in the round, fuzzy glow. Pushing my 4.7-inch refractor up to 145x, I viewed a granular image that grew gradually brighter toward the center. Encouraged, I boosted the power up to 215x. As long as I used averted vision — looking slightly to the side of the object — I was thrilled to witness the outer areas break up into a host of stars. Resolving the core area was just beyond my limits. With the same equipment but under a very dark sky, I stood in awe of M3's vast number of stars. It is truly a magnificent object.

Almost exactly 10° south of Arcturus lies a bright triplet of 5th- and 6th-magnitude stars that fits nicely into a wide-angle view. The brightest, northernmost star is itself a double called **Σ1835**. I could just split it at low power, but moving up to 145x showed an unequal pair 6" apart. This scene reminded me very much of Alcor and Mizar.



NGC 5353
Mag.: 11.1
Size: 2.8' by 1.5'
by Martin C. Germano

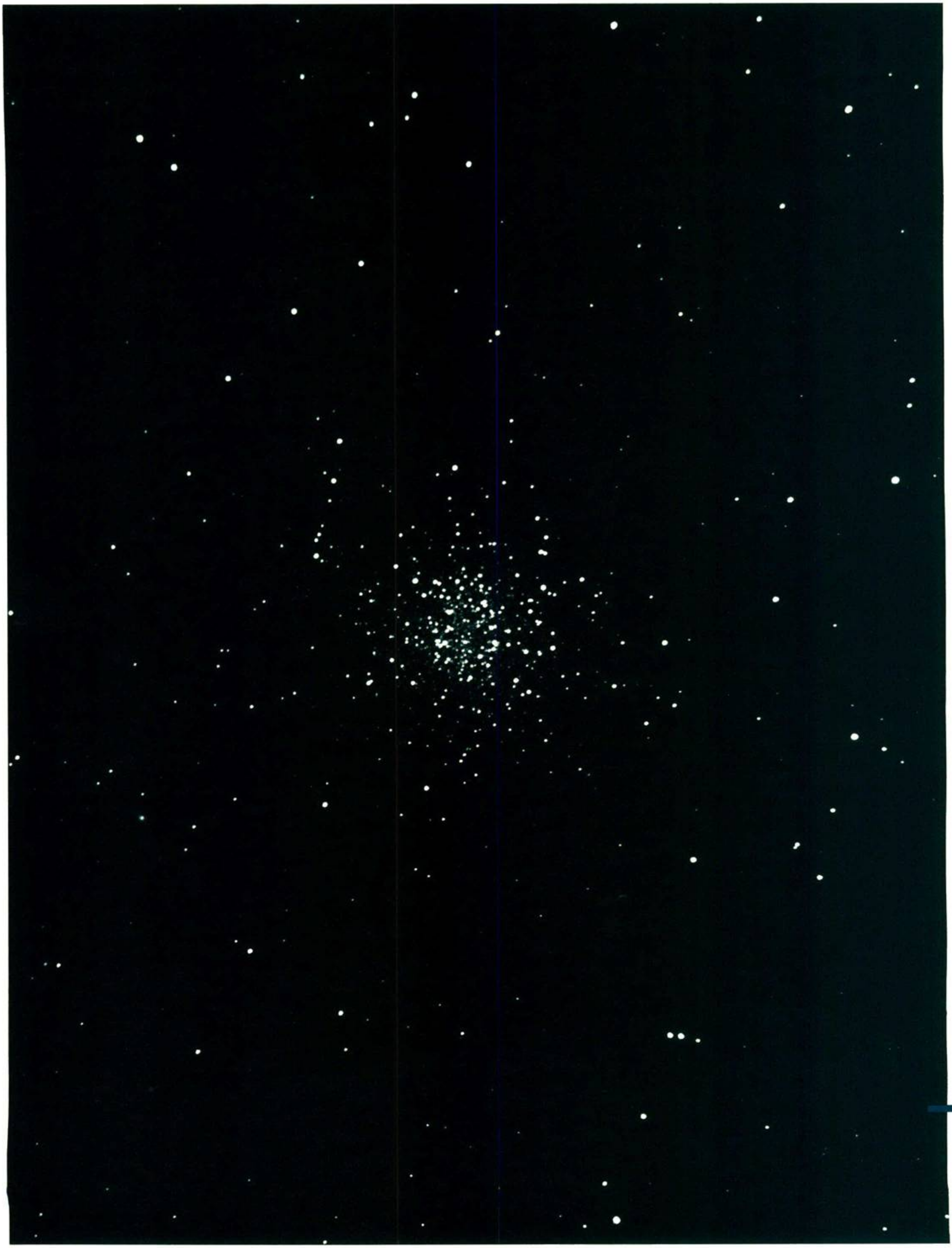
Epsilon Bootis
Mags.: 2.5 and 4.9
Sep.: 2.8"
by John Sanford

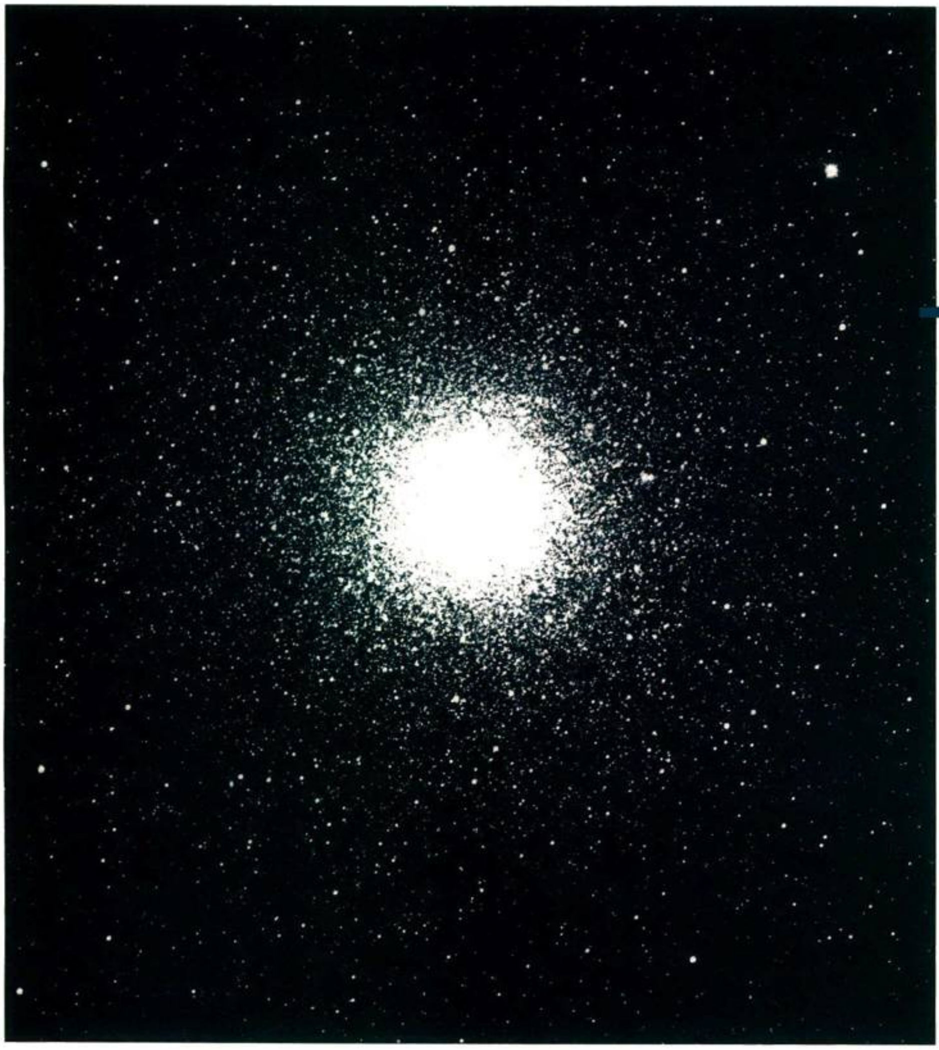
M101
Mag.: 7.9
Size: 26.9' by 26.3'
by Chris Schur

Sliding over to the southeastern part of the constellation, we can see a couple of lone stars on Tirion's *Sky Atlas 2000.0*. The surprise is that this asterism resembles a hockey stick. A star not printed on the atlas represents the stick's end, while the handle at the north end is the double star **Σ1910**. At first glance this is a perfectly matched pair 4" apart. After some study I was sure that the eastern star was the brighter of the two. Because my scope has no clock drive, I watched the brighter star follow its fainter companion out of the field.

You'll find a striking pair of stars tucked away southeast of Arcturus — **Pi Bootis**. At 36x I could just suspect the existence of a second star here. At 145x the pure white stars, separated by 5", were cleanly split. The difference in brightness between the two is just under a magnitude. Just 2° south of this pair you'll find a challenging test for your optics, **Zeta Bootis**. This star was right at the limit of my 4.7-inch refractor — a mere 0.9" gap separates the equally bright bluish-white stars.

Scoot just 30 minutes of right ascension east of Beta Bootis at the top of the kite to land at **Nu^1 Bootis** and **Nu^2 Bootis**. These stars form a lovely and equally bright double. One star is orange, the other blue-white. Not far away lie **Mu^1 Bootis** and **Mu^2 Bootis**. By themselves these stars form a fine pair, but at 145x I saw another split occur — the fainter component is a double, too. The noted 19th-century double-star observer William





M3

Mag.: 6.4

Size: 16.2'

National Optical Astronomy Observatories photo

Henry Smyth called Mu^1 flush white and the fainter pair green-white. The best I could manage was to see a tinge of yellow in Mu^1.

I was very impressed at how well the refractor performed as a deep-sky instrument — it's not just for lunar and planetary observing. Under a dark sky, I trained it on Bootes' only globular cluster, **NGC 5466**. It was a delight just to detect this faint and diffuse object, which is often considered a challenge for 8-inch apertures.

Small scope owners out in darker skies might like to try spotting the brightest galaxies in Bootes. A twist of fate keeps the big and diffuse **M101** (NGC 5474) inside the borders of Ursa Major. But we can include M101 in our survey. It is a premier example of a low-surface-brightness galaxy. The object's total magnitude is 7.9, but it is so huge that its light is spread out over more than half the Moon's diameter. If used under a dark sky site, binoculars show this fuzzy patch of light. A small telescope at medium power can look practically right through it — careful attention is required to find this object.

My favorite trick with M101 is to rock the scope gently back and forth. This triggers my eye's motion detectors, which highlight the faint outer regions of the galaxy. Once I'm satisfied with the overall extent of the galaxy and my eyes are sufficiently dark adapted, I raise the power past 100x in order to see some detail. When you do this you might notice something unusual. In fact your heart rate might jump when you see a relatively bright star well within the galaxy's light. Could this be a supernova? A check of photographs shows it to be a Milky Way star masquerading as a distant interloper.

NGC 5466

Mag.: 9.1

Size: 11.0'

by Preston S. Justis

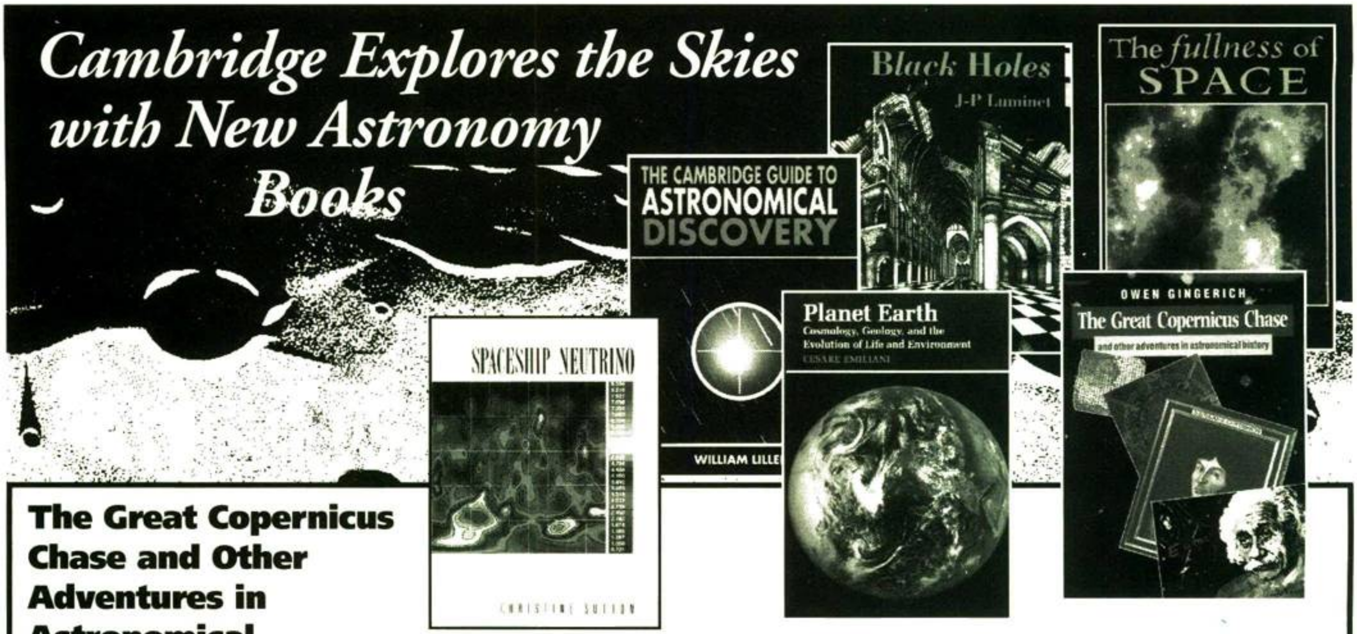
Two galaxies inside Bootes' borders are worth examining. **NGC 5533** lies in the same low-power field as A Bootis, but keep the star out of the field for the best view of the galaxy. I found this magnitude 11.8 object noticeable at 36x. To see any detail in faint objects, you need higher magnification — at 145x I could pick out an obvious starlike core surrounded by a round envelope of faint light.

If you're ready for a break, place your scope on Eta Ursae Majoris, the end star of the handle of the Big Dipper, and turn off your clock drive. Some 45 minutes later the galaxy **NGC 5676** will come drifting into the field of view. Despite its brightness, a half magnitude brighter than NGC 5533, I could just detect this object at 36x. At higher power, NGC 5676 was elongated noticeably north-south, gradually getting brighter toward the middle, where an even brighter core marked the galaxy's center. That's a lot of detail for a 4.7-inch scope!

Colorful double stars abound in Bootes. So if city lights hide your favorite targets in nearby Virgo, you can enjoy an evening of delights in beautiful Bootes. If you find yourself under a dark sky, a great globular cluster and several challenging galaxies fill out the evening's enjoyment. ☐

A regular contributor to ASTRONOMY, *Alister Ling makes the best of any sky condition.*

Cambridge Explores the Skies with New Astronomy Books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The fullness of SPACE
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GETTING HYPER about better photos

Crank up the pressure! Pour on the heat!
Is this any way to treat your film? You bet it is,
if you want to capture the faintest deep-sky objects.

by Kim Zussman

Astrophotography of deep-sky objects is one of the most rewarding aspects of amateur astronomy. Even after ten years as an astrophotographer, I still get butterflies when I first see the negatives after a night capturing photons at the telescope. What those frames show, however, depends on a lot of factors. One of the most important is the type of film.

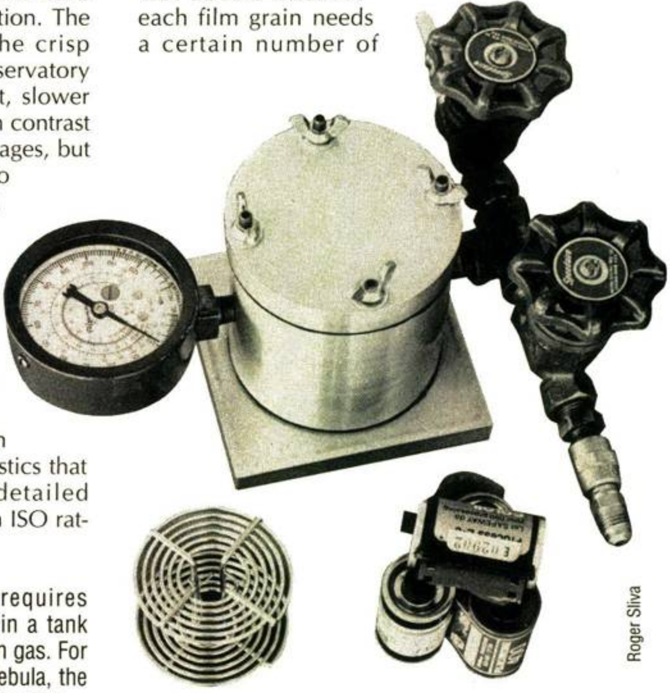
When starting out in astrophotography, I sought films with the highest speed possible. It stands to reason that faint objects such as galaxies would show best using fast films, ones with speeds of ISO 800 to 3200. Fast films should keep the exposure time short. However, fast films have coarse grain and low resolution. The resulting images lacked the crisp detail and resolution of observatory photographs. As I found out, slower films with fine grain and high contrast not only produce sharper images, but can actually be made to record faint nebulae and galaxies more efficiently than films with high speed.

The best film for deep-sky photography is a black-and-white emulsion from Kodak called Technical Pan 2415. Tech Pan provides ultrafine grain and high contrast, characteristics that can produce amazingly detailed deep-sky photos. But with an ISO rating of about 125, it is slow. Normally, a film this slow would be useless for photographing faint deep-sky targets, unless you hypersensitize it.

For amateur astronomers, "hypering" involves baking the film in a pressurized atmosphere of nitrogen and hydrogen for several hours before exposing the film to the night sky. Hypersensitization is now the primary tool amateur astrophotographers use to increase the sensitivity of films.

Incoming Photons

Hypering is necessary because without it Tech Pan, like most films, suffers from "reciprocity failure." This effect occurs because each film grain needs a certain number of



Roger Sliva

HYPERSENSITIZING FILM requires "soaking" the unexposed roll in a tank filled with nitrogen and hydrogen gas. For his 2-hour portrait of the Veil Nebula, the author used hypered Technical Pan film.

photons to hit it before it permanently reacts to the light. During long exposures of faint objects there's lots of time between the arrival of the incoming photons. This allows the film grains to chemically relax and release what little energy they've captured from previous photons. As a result, little or no image builds up even after exposures of several hours.

Reciprocity failure produces film behavior that seems contrary to common sense. After all, if a film needs a short exposure for a bright object, it follows that a long exposure should work for recording a faint object. An object half as bright should require an exposure twice as long.

This relationship between exposure time and image brightness is known as the reciprocity law. As a film is exposed to increasing amounts of light, it blackens or increases in density. (Remember, we're talking about original negatives on which areas exposed to light turn black and areas receiving little light remain clear.) The reciprocity law states that exposure density equals the intensity of the light from the object multiplied by the duration of the exposure.

According to the reciprocity law, a film that needs one second of exposure to record the Moon with a given telescope should require 1,000 seconds of exposure to record a galaxy with $^1/_{1,000}$ the surface brightness of the Moon. However, most films will need more than 1,000 seconds to record the galaxy — the reciprocity law fails at low light levels.

You can reduce reciprocity failure in a number of ways. Cooling the emulsion cuts down on reciprocity failure, a discovery that spawned the "cold camera." These devices use frozen carbon dioxide, or dry ice, to chill the film to about –80° F. Cold cameras work very well and are favored by many ardent astrophotographers for use with color film. But cold cameras can be tricky to use at the telescope. (For more about how they work, see "ASTRONOMY Tests the Northern Lights Cold Camera," July 1989.)

As an alternative, Kodak's Technical Pan film incorporates fine grain, high contrast, and when hypersensitized, low reciprocity failure and reasonable speed. In 35mm rolls the film is called 2415. The same emulsion is also available in 120-format as Tech Pan 6415 and in 4x5 and 8x10 sheet film sizes as 4415.

Dessicating the Film

Hypering is essential with Tech Pan and turns it into a powerful astrophoto film. But color films benefit from hypering as well, particularly print films such as the popular Fuji-Color Super HG 400.

Hypering works by removing the oxygen and water from the emulsion of the film. Dissolved oxygen and water increase conductivity in the film's atoms, which enables the film grains to relax between incoming photons, increasing reciprocity failure. How sensitive the film becomes also depends on the temperature — heating the film during treatment greatly reduces hypering time. Baking the emulsion in pure hydrogen produces the greatest speed increase but can also produce unwanted explosive results!

Among amateur astrophotographers, the most popular method is baking the film in a mixture of nitrogen and hydrogen known as forming gas. Forming gas made of 92 percent dry nitrogen and 8 percent hydrogen gives excellent results without the hazard of pure hydrogen.

The best way to get started is to simply purchase hypered film from one of several suppliers. When you get the film, be sure to keep it frozen in a moisture-proof container until you want to use it. If the film absorbs moisture again, it will lose its sensitivity and become fogged.

Once you master the nuances of astrophotography with hypered film, you may want to consider "rolling your own." Because you have greater control over what happens to the film after it is treated, hypering your own film produces more consistent results than using store-bought hypered film. You can purchase hypering kits from Lumicon in Livermore, California. Or you can build your own setup with readily available materials.

Building a Hypering Kit

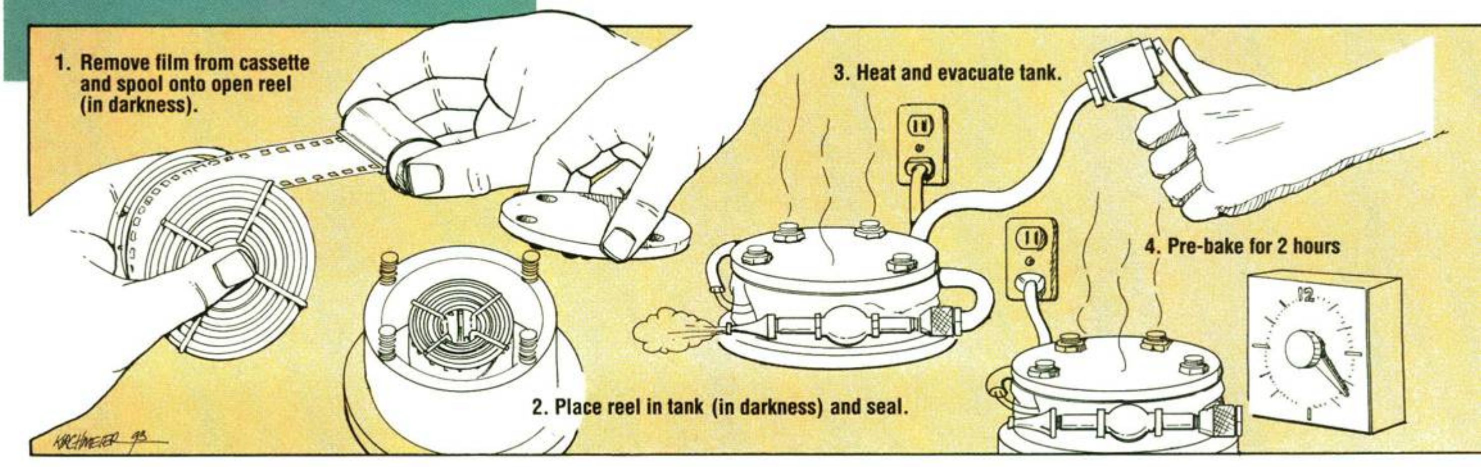
To hyper film at home you need a light-proof, pressure-tight container. The one I use consists of a welded aluminum tank with a door on one side to allow me to insert film. You can seal the door with a rubber O-ring, although I've found that "Form-a-Gasket" material available from the local hardware or auto supply store also works well. The tank must be large enough to hold a typical developing-tank reel. Although you can hyper film

RECOMMENDED FILMS FOR HYPERING

Hours at 18 PSI on an open reel

Film	45°C	50°C	55°C	Speed Gain
Kodak Tech Pan	130-160	80-100	50-60	10x
Fujichrome RD100	15	10	6	5-8x
Kodak Ektar 125	36	24	15	3x
Fuji Super HG 400	24	16	9	3-6x
Kodak Ektar 1000	24	16	9	2-3x
Konica SRG 3200	24	16	9	2-3x

Figures apply to Lumicon equipment using 92% nitrogen/8% hydrogen forming gas. Hypering times will vary when using homemade hypering tanks. Figures are courtesy Lumicon and are reprinted with permission.


1. Remove film from cassette and spool onto open reel (in darkness).
2. Place reel in tank (in darkness) and seal.
3. Heat and evacuate tank.
4. Pre-bake for 2 hours
12

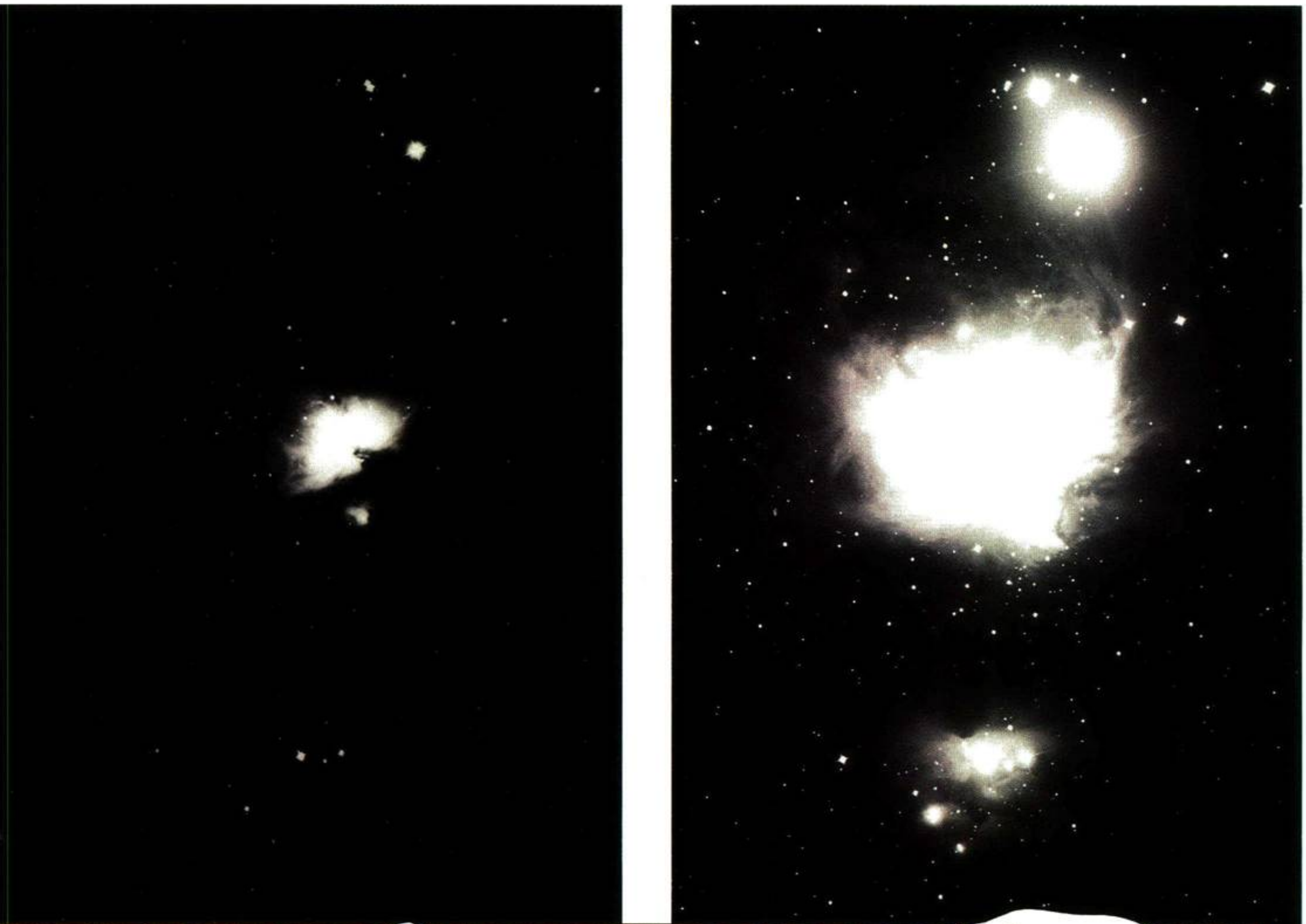
HOME HYPERING is a step-by-step process that can take several days. But with this process, unlike the cooling process of the cold cameras, all the work is done before you get to the telescope.

while it is in its original cassette, the results are often non-uniform along the length of the film. It is far better to spool the film onto an open reel for hypering and then wind it back into a cassette for use in the camera.

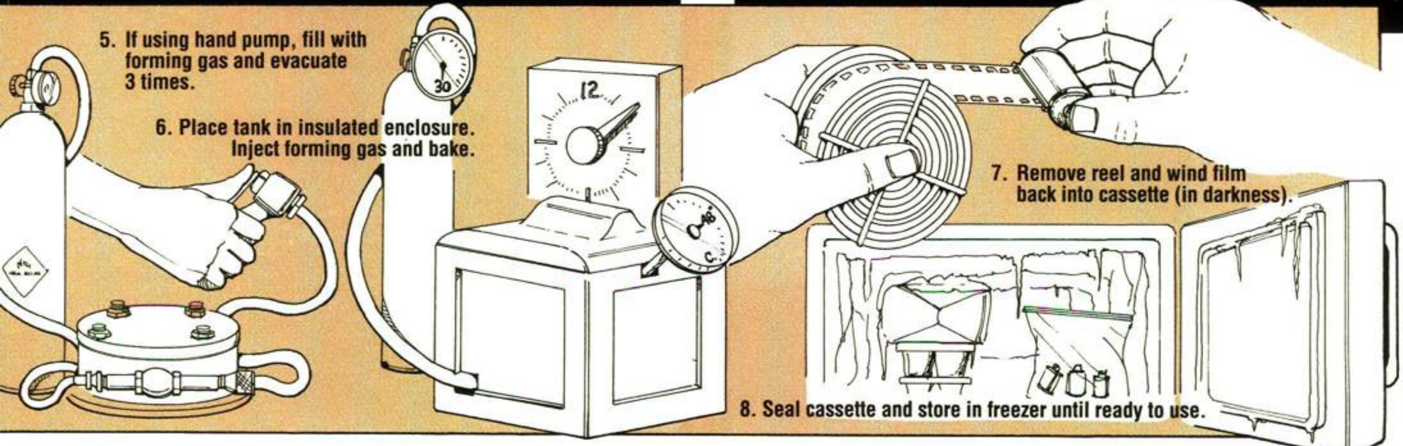
The tank must also have gas inlet and outlet valves and a pressure/vacuum gauge. To heat the tank and its contents I wrap the tank with electric heat tape normally used to keep water pipes from freezing.

Since temperature is critical, the tank should also have a thermostatic regulator. The thermostat I use is permanently set to 48° C, but any constant temperature between 45° and 60° C will work, the important point being that the temperature not fluctuate during hypering more than 1° C. Because the tank loses heat to the surrounding air, hypering time can vary from season to season depending on how warm your room is. To avoid this, I wrap my tank in fiberglass insulation and duct tape and then place it in a foam picnic cooler.

For a gas source, I use a type "Q" cylinder, which contains 70 cubic feet of nitrogen/hydrogen forming gas, purchased from a local gas supplier. (Look under "Welding Supplies" in the Yellow Pages.) The gas should also be as free of water and oxygen as possible. If

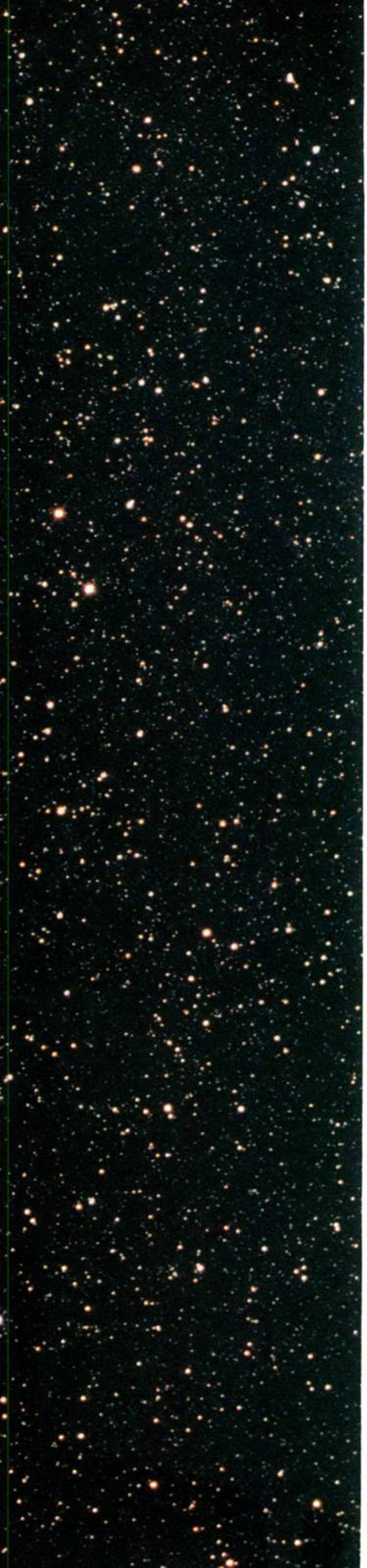


HYPERING MAKES ALL THE DIFFERENCE. Both photos are 20-minute exposures taken by Michael Stecker on Tech Pan film. The left photo was taken on film straight out of the box; the right photo was taken on hypered film.



5. If using hand pump, fill with forming gas and evacuate 3 times.
6. Place tank in insulated enclosure. Inject forming gas and bake.
7. Remove reel and wind film back into cassette (in darkness).
8. Seal cassette and store in freezer until ready to use.
12
30
48° C

ASTRONOMY: Phil Kirchmeier



you use a cylinder you'll also need a regulator to reduce the pressure to 20 pounds per square inch (PSI) or less. As an alternative to large tanks, which can cost $150 to $200, you can purchase small tanks of forming gas from Lumicon.

You'll also need a vacuum pump. Inexpensive hand pumps such as the Mighty-Vac models work, but a good-quality electric pump is more efficient. I use a surplus Welch Duo-Seal roughing pump. These are available from surplus stores for under $150.

Hypering Step by Step

To hyper film you first need to load the film onto the open reel. Be careful not to kink the film or touch the emulsion surface. This can be tricky the first few times you try it since this step must be done in total darkness. Once the reel is in the tank and the tank is sealed, you can turn on the lights.

For the next step, I pump the air out of the tank and plug in the electric heater. I've found that heating the film under a good vacuum for two hours greatly reduces the time needed for baking in forming gas later on.

After the initial vacuum baking, I then fill the tank with forming gas. Lumicon recommends 3 PSI above atmospheric pressure (18 PSI total) for their kits. For my setup, I like to fill the tank to 15 PSI above atmospheric pressure, or 30 PSI. You can use less pressure and save gas, but hypering will take longer. If you are using a hand pump, Lumicon also recommends three cycles of evacuation and filling with forming gas to remove all traces of air before the final treatment.

Once the tank is charged with forming gas, bake the film for a predetermined time (see the table on page 66 for guidelines for Lumicon kits). After baking, turn off the lights and remove the reel from the tank. Carefully spool the film back into its cassette. Place the cassette into a standard plastic film can and then seal the can with electrical tape to prevent moisture from re-entering the film. I then place the sealed can in a "zip-loc" plastic bag and store it in a freezer. Hypered Tech Pan holds up well if sealed and frozen but it is still best to use it within a month of hypering.

HYPERING ALSO WORKS FOR COLOR FILM. For his 15-minute exposure of the Veil Nebula, Jim Riffle used hypered Fuji Super HG 400 and a 760mm-focal-length f/4 Flat Field Camera.

Getting Too Hyper

All kinds of variables can affect hypering results: time, temperature, pressure, and vacuum prebake. There is no "best" combination. But you can tell when your film is hypered to an optimum level. To do that you look for "hyper fog," a darkening of the unexposed developed negative compared to unhypered film. Hyper fog increases as film is hypered longer.

Underhypering produces a negative that looks almost transparent. Overhypered film is too dark. To measure film darkness or density you can use a device called a densitometer. A cheaper alternative is to compare the negative to standard step wedges. Step wedges are pieces of acetate film with a series of shaded blocks of known density and are available from photo supply houses.

When aiming for the best hypering routine with Tech Pan film, develop the film in Kodak D19 at 20° C for 5 minutes. The optimum hyper fog level under these conditions should be a density of 0.3 to 0.4. (A negative with a density of 1.0 transmits only 10 percent of the light and is severely overhypered.) If you choose to increase Tech Pan's speed by developing for longer than 5 minutes, the fog density will increase. I regularly develop for 10 minutes and aim for a density of 0.6.

In your trial-and-error experiments, keep the developing time to 5 minutes, keep all other factors standard, and adjust only the hypering time until the hyper fog reaches 0.3 to 0.4. Once you have a good combination, you can experiment with shortening the hypering time for the sake of convenience by increasing the baking temperature. Within the recommended 45° to 60° range, raising the temperature 7° C reduces hypering time by half. However, both over- and underhypering reduces film speed.

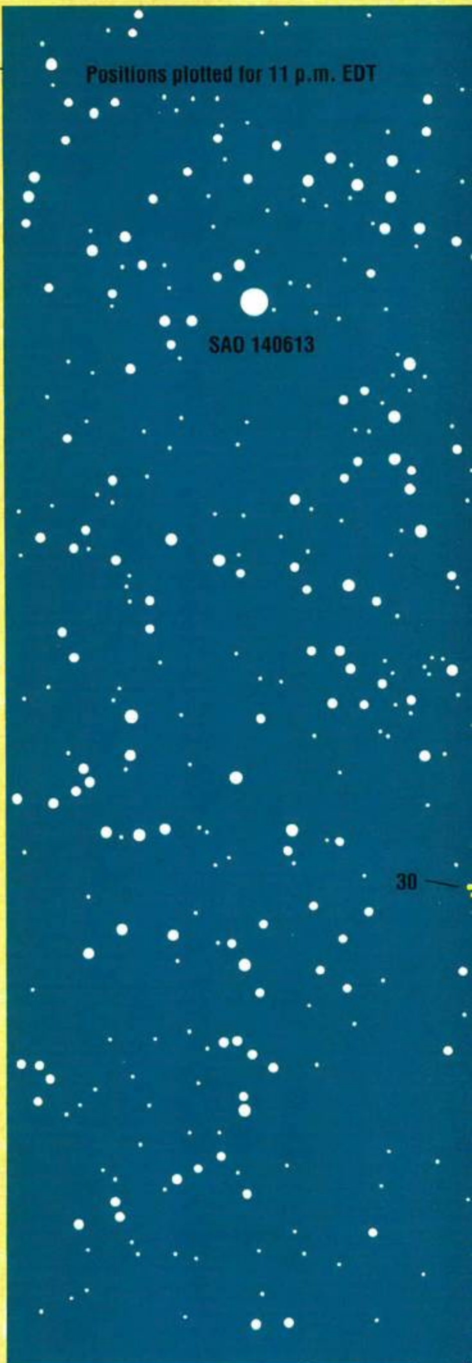
With my system, I've found two hours of vacuum treatment followed by baking in forming gas at 48° C for 24 hours gives the best results with Tech Pan film. But your own home setup will inevitably require different times and temperatures. After some experimentation, you'll be able to produce hypered film capable of recording faint deep-sky objects in stunning detail. ☐

Kim Zussman is one of North America's leading astrophotographers whose photos appear regularly in ASTRONOMY. *A description of his astrophotography techniques appeared in the June 1989 issue.*

PLUTO WATCH

Track the elusive world at the edge of the Sun's domain.

by David J. Eicher

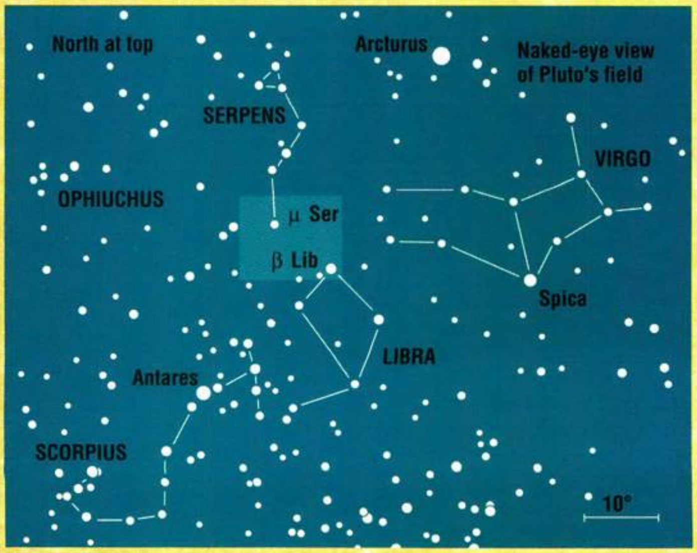

Positions plotted for 11 p.m. EDT
SAO 140613
30

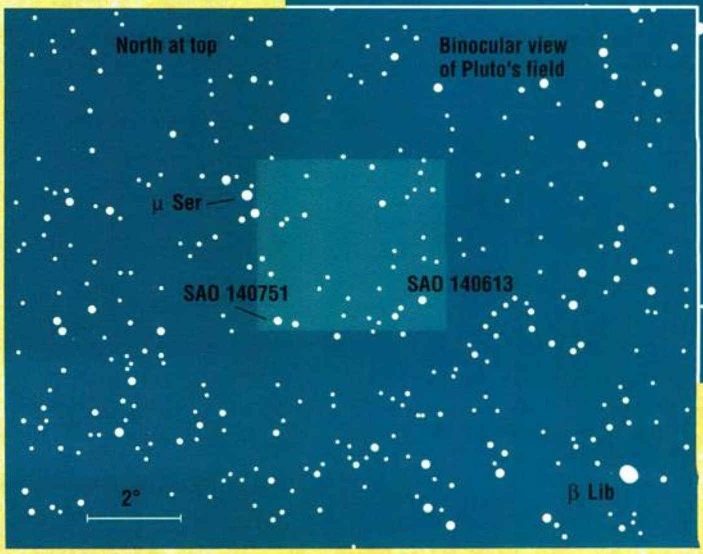
Pluto is uniquely paradoxical among the planets. This elusive, yet highly attractive target carries the mystique of being the last unexplored frontier of the solar system. You may see fainter things and you'll certainly see farther ones, but spotting this little world on the twilight edge of the Sun's domain packs a thrill second to none. The small, rocky iceball, which was discovered in 1930, reaches opposition on May 14, when it will be 28.8 astronomical units, or 2.7 billion miles, from Earth. Although Pluto is no more than a speck of light in the eyepiece, it is a spectacular sight, given the knowledge of what you are seeing.

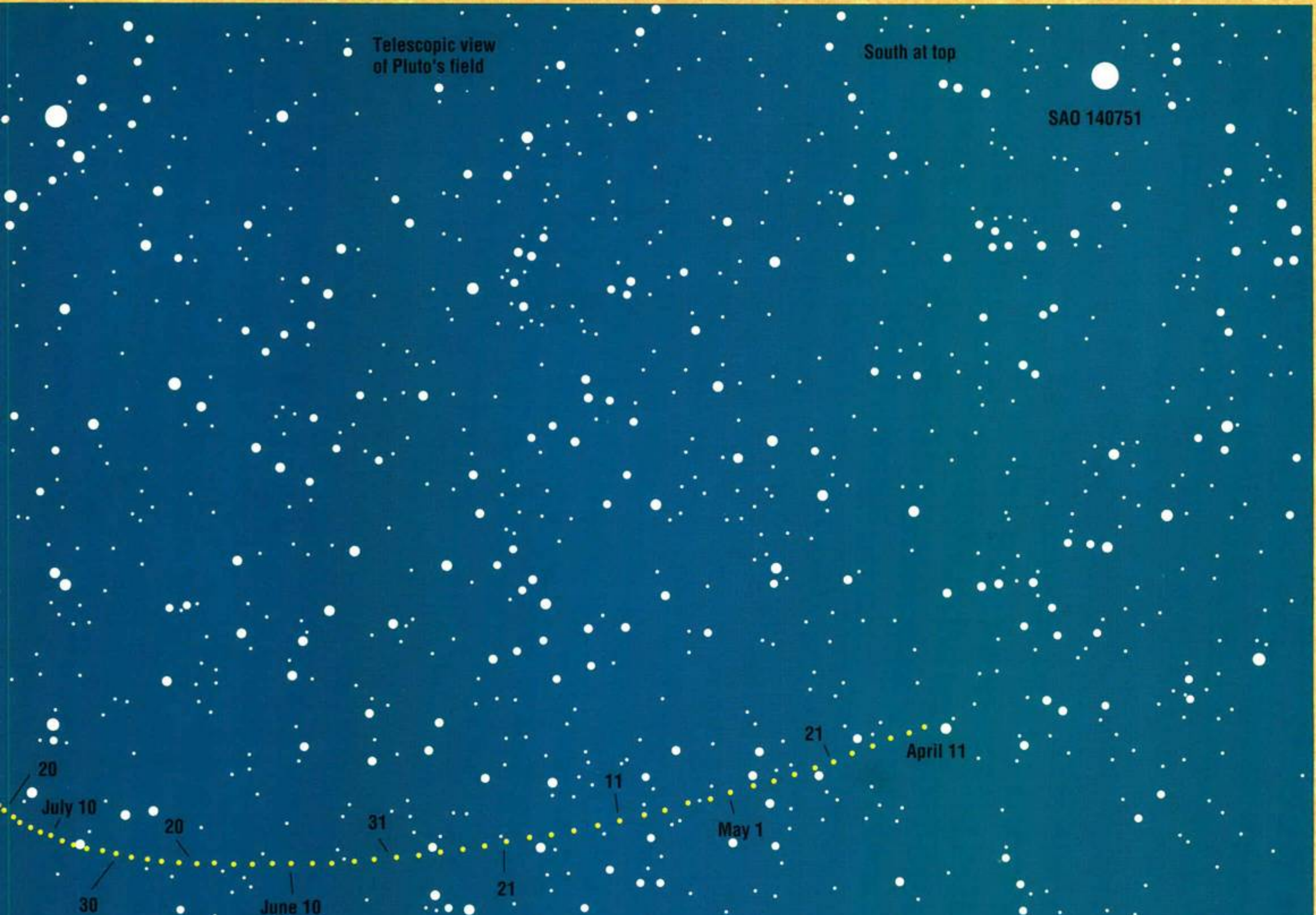
Pluto's size is not precisely known, but it certainly is the smallest planet, measuring about 2,400 kilometers across. The combination of small size and great distance makes the planet faint in Earth's sky. Uranus and Neptune are easily visible in binoculars. But Pluto glows dimly at magnitude 13.7, making it appear like a faint "star" even in the largest telescopes. The smallest instrument that will show the distant planet is a 6-inch or 8-inch scope.

This year Pluto tracks through a small piece of northern Libra, a rather unremarkable constellation sandwiched between the brighter star groups Virgo and Scorpius. The key to finding Pluto is to locate the correct starfield. First find the magnitude 3.5 star Mu (μ) Serpentis, visible on the naked-eye and binocular charts. From Mu, move 4.5° southwest to SAO 140613, a magnitude 6.5 star that is visible in the upper left-hand corner of the telescopic chart. This star serves as the jumping off point to star hop to the track of Pluto in the chart.

To be sure you've seen the distant planet, you'll need to observe its motion. After zeroing in on Pluto, make a sketch of the field you see. Make another sketch a day or two later. You can then compare the drawings and identify Pluto by its slight motion against the stars. If you observe or photograph the elusive planet, ASTRONOMY wants to hear from you. ☐


North at top
Arcturus
Naked-eye view of Pluto's field
SERPENS
VIRGO
OPHIUCHUS
μ Ser
β Lib
Spica
LIBRA
Antares
SCORPIUS
10°


North at top
Binocular view of Pluto's field
μ Ser
SAO 140751
SAO 140613
2°
β Lib


Telescopic view of Pluto's field
South at top
SAO 140751
April 11
21
May 1
11
21
31
June 10
20
30
July 10
20
0.5°

ASTRONOMY: all maps by Phil Kirchmeier

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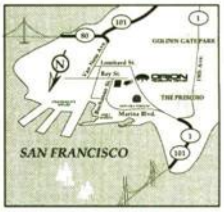

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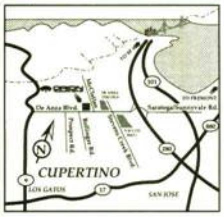

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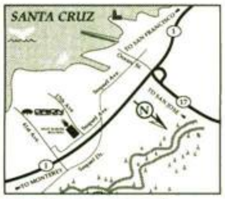

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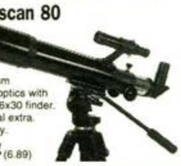

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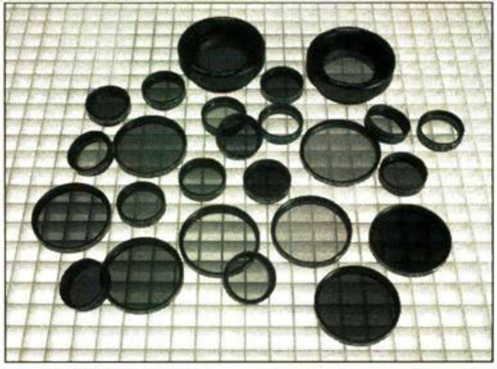

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BUILD A LENSLESS SCHMIDT CAMERA

This telescope uses a simple spherical mirror to produce nearly perfect star images at both the center and edges of your astrophotos.

Story and photos by Peter Ramberg

You don't have to put up with less-than-perfect star images at the edges of your astrophotos. And you don't need complex equipment to get excellent images either. A simple, inexpensive telescope that you can build in one or two weekends is all you need.

Most scopes produce nearly perfect images at the center of the field of view, which is fine for visual use. But the same scopes often form cometlike or oval-shaped star images at the edge of the field because of the scopes' optical design. For astrophotography you want sharp images over the entire field. Such images are the forte of the camera designed by German optician Bernhard Schmidt. By using a spherical mirror, Schmidt avoided the problems *inherent* with designs such as the Newtonian reflector.

Images "off axis," toward the edge of the field of view, in a Newtonian appear cometlike. Opticians call this condition coma. It occurs in a Newtonian telescope because light rays entering the scope at an angle, or off axis, hit the parabolic primary mirror differently than rays that strike the mirror head-on. The off-axis images also display astigmatism, which causes stars at the edge of the field to appear as ellipses. Coma is by far the larger of the two effects.

Schmidt got rid of coma and astigmatism by using a spherical mirror instead of a parabolic mirror as in a Newtonian reflector. But the spherical mirror is not sufficient by itself to prevent coma in off-axis images. So he placed the entrance aperture (opticians call it the entrance pupil) at the center of curvature of the mirror, which lies at a distance of twice the mirror's focal length. The entrance pupil has a diameter somewhat smaller than that of the primary mirror and ensures that all rays strike the spherical mirror in exactly the same way, thus preventing coma and astigmatism.

The spherical mirror introduces a new image imperfection, spherical aberration, which makes stars appear large and faint. Schmidt removed this aberration in his fast cameras by inserting a lens at the entrance pupil. This lens has a difficult shape to make, so most amateur telescope makers do not attempt to follow Schmidt's camera design exactly. But by increasing the focal length of the camera to reduce the effects of spherical aberration, telescope makers can build a lensless Schmidt camera and still take advantage of the benefits of Schmidt's coma-free design.

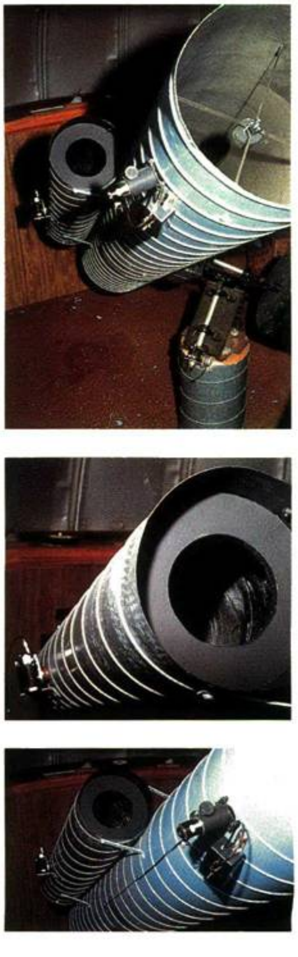
A Long Focal Length is the Key

Schmidt cameras with corrector lenses usually have very fast focal ratios of about f/1, indicating the focal length of the mirror is the same as its diameter. Focal ratios in lensless Schmidts typically range from f/3 to f/5, depending upon the amount of aberration the user can tolerate in the final images. By increasing the focal length until you reduce the amount of image smearing to the same as the amount introduced by Earth's atmosphere, you will obtain the best images the camera can provide.

The long focal length of a lensless Schmidt has an added advantage. Like Newtonian reflectors, a Schmidt camera focuses across a curved surface instead of across a flat surface like a CCD or the film plane of a 35mm camera body. The radius of the curved focal plane is the same as the focal length of the primary mirror. You can minimize the curvature of the focal plane and thus use a 35mm camera body instead of a specially designed curved film holder by using a longer focal length. Of course, you want to make the camera as fast as possible at the same time, so your final design must consider equally speed, spherical aberration, and the curved focal plane.

I balanced these three items by choosing an 8-inch mirror with a 24" (600mm) focal length and 5-inch entrance pupil. The focal length provides a 3° field of view and a focal plane that is only slightly curved. The 5-inch entrance pupil increases the focal ratio from f/3 to f/4.8, slow enough to reduce spherical aberration to a tolerable level but fast enough to take astrophotos in a short time.

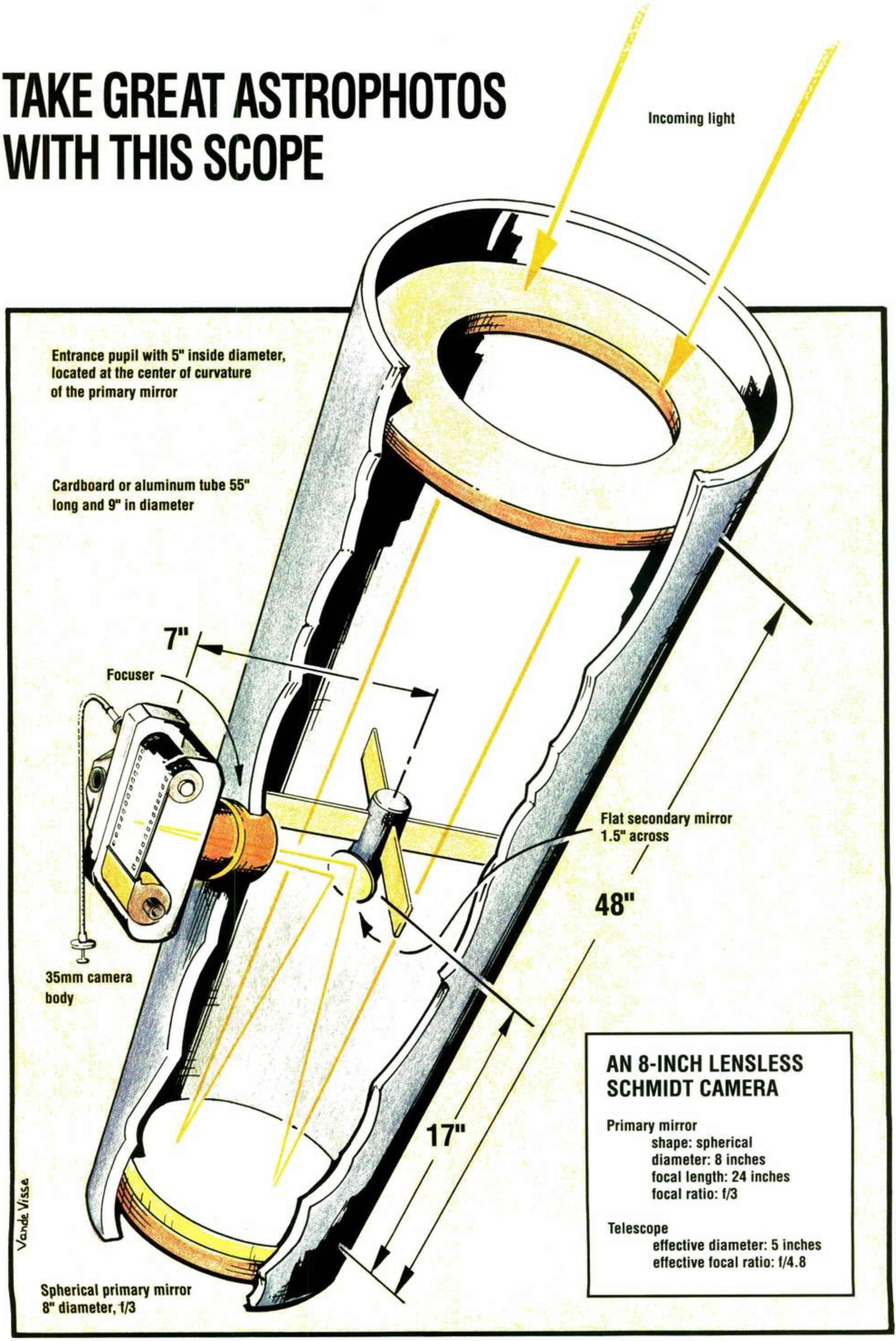
Building the camera is easy and relatively inexpensive. The camera costs as little as $150 to build, not including the primary mirror or 35mm camera body. (The price does include a commercially made flat secondary mirror.) Because the spherical mirror is easy to make, unlike the parabolic mirror needed for a Newtonian reflector, you might even want to grind your own mirror. You can buy an 8-inch mirror kit for under $100. Or you can purchase a spherical mirror from an optical company, boosting the total cost (not including a 35mm camera body) of the Schmidt camera to



REDUCING IMAGE IMPERFECTIONS is the job of the diaphragm located at twice the focal length of the spherical primary mirror.

OBTAIN SHARP STAR IMAGES as in this image of the Lagoon Nebula (M8) using a lensless Schmidt camera.

TAKE GREAT ASTROPHOTOS WITH THIS SCOPE


Incoming light
Entrance pupil with 5" inside diameter, located at the center of curvature of the primary mirror
Cardboard or aluminum tube 55" long and 9" in diameter
7"
Focuser
Flat secondary mirror 1.5" across
48"
35mm camera body
17"
Spherical primary mirror 8" diameter, f/3
Vande Visse

AN 8-INCH LENSLESS SCHMIDT CAMERA

Primary mirror

shape: spherical
diameter: 8 inches
focal length: 24 inches
focal ratio: f/3

Telescope

effective diameter: 5 inches
effective focal ratio: f/4.8

ASTRONOMY: Lee Vande Visse

FAINT GALAXY COMPANIONS to the Andromeda Galaxy appear at top (M32) and bottom (NGC 205) in this 15-minute exposure on Ektar 1000.

around $500 — still cheap compared with commercial Schmidt cameras of the same diameter. (Don't try to cheat and use a short-focus parabolic mirror you may have lying around instead of a spherical mirror. Your astrophotos will suffer from coma if you do.)

Building the Camera

You need only a few parts to build an 8-inch Schmidt camera: a tube 55" long, a focuser, a primary mirror, a mirror mount, a flat secondary, a "spider" support for the secondary, and some plywood for the aperture that defines the entrance pupil. Many building supply stores sell concrete forms that work well as telescope tubes (Sonotube is one brand name). I had my tube made at a local sheet-metal shop. Whatever the material, the tube should have an inside diameter of 9" so air can circulate around the mirror. The length of the tube accommodates the 48" needed between the mirror and the entrance aperture, plus some extra space for mounting the mirror and entrance aperture.

The secondary mirror has an elliptical shape because it is mounted at a 45° angle to the long axis of the telescope. Viewed from the front end of the scope, the elliptical mirror takes on a circular shape. The smaller axis of the mirror, which is equal to the diameter of the apparent circle of the projected mirror shape, is 1.5". This size minimizes the light blocked by the secondary (30 percent by diameter compared with the scope's 5" effective diameter) and produces no vignetting of the image.

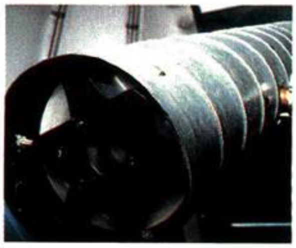
If you wish to make the primary mirror mount and secondary support, read a book about telescope making such as Richard Berry's *Build Your Own Telescope*. He tells you how to build a variety of mirror mounts and secondary supports. Or you can buy the mirror mount and secondary support from one of the advertisers in ASTRONOMY. I used a spider support for the secondary mirror because it resists vibration better than a single rod.

When you have gathered all of the pieces, drill all of the necessary holes in the tube before you install any parts. A hole about 1.5" in diameter is needed in the side of the tube 17" from the front of the primary mirror. (The exact size and distance of the hole depends on the diameter and height of your focuser.) Then paint the inside of the tube flat black to reduce scattered light. Paint the outside of the tube any color you wish.

Paint the primary mirror mount and the secondary support flat black, if they haven't already been painted, and then mount the mirrors in their holders. Install the secondary mirror first. Place the center of the secondary so it lies 17" from the front of the primary mirror. The secondary mirror should reflect light through the 1.5"-diameter hole in the side of the tube. The position of the secondary gives about 2" outside the tube to accommodate the thickness of the 35mm camera body and to allow for focusing. Next install the primary mirror.

Cut the entrance aperture from 1/4" plywood, masonite, or thin aluminum and paint it flat black like the other telescope parts. The disk has an outer diameter of 9" and a hole 5" in diameter at the center. This hole defines the aperture of the telescope and helps to reduce the amount of spherical aberration by increasing the focal ratio to f/4.8. A larger aperture increases spherical aberration to unacceptable levels. Insert the entrance aperture into the tube and hold it in place with screws. Be sure that the disk lies 48" from the front of the primary mirror (that is, at the center of curvature of the f/3 primary mirror).

You should use a low-profile focuser to hold the camera. These are available ready-made from several manufacturers. Or you can build a simple focuser from metal tubes or pipe fittings (see Berry's book) or even from a slotted aluminum bar that attaches the camera to the tube



A THREE-POINT SUPPORT holds the primary mirror. Seventeen inches away another support holds the flat secondary mirror.

by the tripod fitting in the camera's base. If you use a simple bar to hold the camera body, insert a long T-tube into the camera. You want the tube to just stick into the telescope tube so scattered light doesn't accidentally strike the film. Whatever focuser you use, be sure that you can lock the camera into position after focusing so it doesn't shift during long exposures. If you use a focuser that can hold eyepieces and not just a camera body, you can also use the lensless Schmidt as a rich-field telescope when you're not taking astrophotos. (See "A Visual Lensless Schmidt" at left.)

With everything in place, you need to align or collimate your mirrors. You can do this just as you would for a Newtonian reflector. For detailed instructions, see the article "How to Collimate Your Telescope" in the April 1992 issue.

Using the Camera

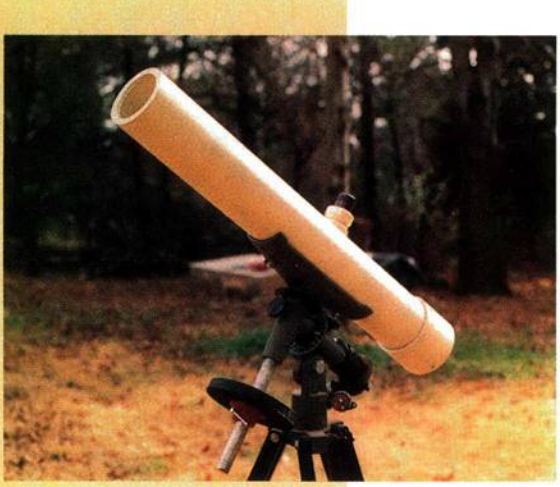
Install the Schmidt camera onto your mounting along with a guide scope, and give the camera a test drive. Load the 35mm camera body with film and focus on a star cluster or other bright object. The shutter of the camera body may cause image vibration and blurry images. If so, use the "hat trick" and cover the end of the tube with cardboard until the shutter vibrations die down before you start an exposure.

Taking astrophotos with this camera is a breeze. The fast focal ratio enables you to capture faint galaxies and nebulae on film in just 15 minutes. And the short focal length forgives many errors in guiding — for example, I was stung by a bee during the M8 exposure shown at the beginning of this article.

The combination of a fast f/ratio, nearly perfect images across the field, and ease of construction makes the lensless Schmidt camera a real winner. Whether you use 35mm film or a CCD, you are in for a real treat when you look at your first pictures taken with this telescope. ☐

Peter Ramberg teaches computer science and has pursued his interest in astronomy for over 20 years.

A Visual Lensless Schmidt


John Pataky

Backyard astronomers traditionally choose among several instruments for low-power, rich-field viewing: large binoculars, short-focus Newtonians, and apochromatic refractors. Large binoculars and apochromatic refractors are expensive, and short-focus Newtonians have bothersome coma, fan-shaped distortion of star images, near the edge of the field of view. Another alternative is a lensless Schmidt telescope. You can build a lensless Schmidt cheaply (under $100 if you grind the simple mirror yourself), and its images are coma free.

A key element in Bernhard Schmidt's telescope design is the entrance aperture, placed at twice the focal length of the mirror, which removes coma from the image. Many telescope builders try to shorten the tube of a Schmidt telescope by placing the aperture closer to the mirror, but they lose coma correction.

Schmidt's design also includes a lens to remove image blurring, or spherical aberration, caused by the spherical mirror. For low magnification and the proper focal ratio, spherical aberration is not noticeable and you can dispense with the lens.

My lensless Schmidt uses a 4.25-inch-diameter spherical mirror with a focal length of 16". The entrance aperture has an inner diameter of 3.5" and sits 32" from the front of the mirror. The combination of the mirror's focal length and the diameter of the aperture yields an effective focal ratio of f/4.6. The tube is simply PVC tubing and the eyepiece holder consists of a pipe-to-PVC connector. The secondary mirror is an elliptical flat mirror that is 1.25" across and sits about 13 inches from the primary mirror.

Star images in my scope appear slightly larger than the theoretical diffraction disk, owing to spherical aberration. But the images are acceptable for viewing with a 25mm eyepiece at 15 power, especially considering the 4° field of view with no coma to the very edge.

The short focal length requires accurate collimation of the mirrors, but you can do this during the daytime. Stick to 1.25"-diameter eyepieces: The curved focus affects larger diameter eyepieces. Spherical aberration limits the use of high-power eyepieces, but you'll appreciate the crisp images in wide-field views given by this scope with low-power eyepieces. — *Robert P. Miller*

A FOCUSER CAN BE AS SIMPLE as a slotted bar with a sliding bolt, or you can buy a ready-made focuser.

THE SOFT RED GLOW of hydrogen gas in the Orion Nebula (M42) shows up easily in this 15-minute exposure on Fujicolor Super HG 400.

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WINTER OBSERVING ROUNDUP

As 1992 ended, several exciting sky events kept backyard astronomers busy despite the bitter cold temperatures that hung over regions of the country. Mars worked its way toward opposition in early 1993, the Geminid meteor shower put on a good show, and Comet Swift-Tuttle displayed an active nucleus with rapidly changing details.

Best Views of Mars Since 1990. With a diameter approaching 15" and a high elevation in the constellation Gemini, Mars attracted many observers last winter. The current apparition afforded skywatchers the best views of the Red Planet since 1990. Those with scopes of 4 inches or more saw dark patches and other detail on the Martian surface.

"The North Polar Hood is breaking up and the North Polar Cap is visible," says Daniel M. Troiani of Schaumburg, Illinois, about his November 28, 1992 observation. Troiani, who is assistant Mars recorder for the Association of Lunar and Planetary Observers, used a 17.5-inch f/4.5 reflector at 410x and 630x, and Wratten #25 (red), #47 (blue-violet), and #80A (light blue) filters. "With the #47 filter I observed many high clouds in the northern hemisphere of Mars," reports Troiani. "The planet showed many dust clouds throughout October and November, which suggests that small dust storms may be more common than we previously thought." Troiani also reports that British observers watched dust cloud activity in the Chryse Basin in early October.

Geminids Strong in Moonlight. "Despite the strong light from a gibbous Moon, it was an impressive year for the Geminid meteor shower," proclaims George W. Gliba of Greenbelt, Maryland. Gliba observed the shower on the peak night of December 13/14, 1992. "In one hour I saw 39 meteors, 35 of which were Geminids," reports Gliba. "Two Geminids shone at magnitude –1 and showed a beautiful blue-green color," he says.

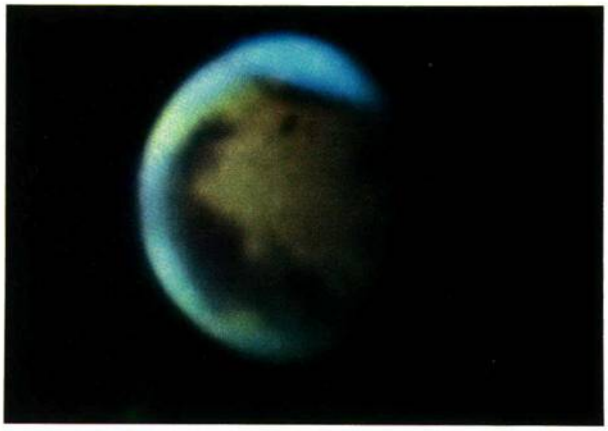
Eric Vondra of Kissimmee, Florida, was equally enthusiastic about the Geminid show. "This year's count was down due to the moonlight, but the shower was still worth watching," he says. "In my first hour of observing on December 12/13, I logged 25 Geminids and four four random meteors. I thought that many of the Geminids this year appeared white, whereas in the past they seemed more yellowish."

From Glen Ullin, North Dakota, Jay Brausch watched the Orionid meteor shower peak between October 20 and 25, 1992. He observed a total of 55 meteors over portions of the six nights and found that most were quite faint. Brausch did spot a particularly bright one, a magnitude –4.9 meteor, on October 21. "Although most were faint," he says, "I spotted a beautiful orange Orionid as bright as Sirius blaze across Cetus on October 25."

On January 3, 1993, Frank J. Melillo of Holtsville, New York, watched the peak of the Quadrantid meteor shower. "From 5:00 to 6:00 a.m. EST, I saw few Quadrantids," he reports. "I counted only seven during the hour and was surprised that the period of maximum activity would be so quiet." ☐

ASTRONOMY wants to hear about your observations of the sky. Please send reports, sketches, and photographs to David J. Eicher, Reader Reports Editor, ASTRONOMY, P.O. Box 1612, Waukesha, WI 53187.

COMET SWIFT-TUTTLE returned in 1992 and gave observers a great show, including swirling jets from the comet's nucleus. Photo by Ronald E. Royer.



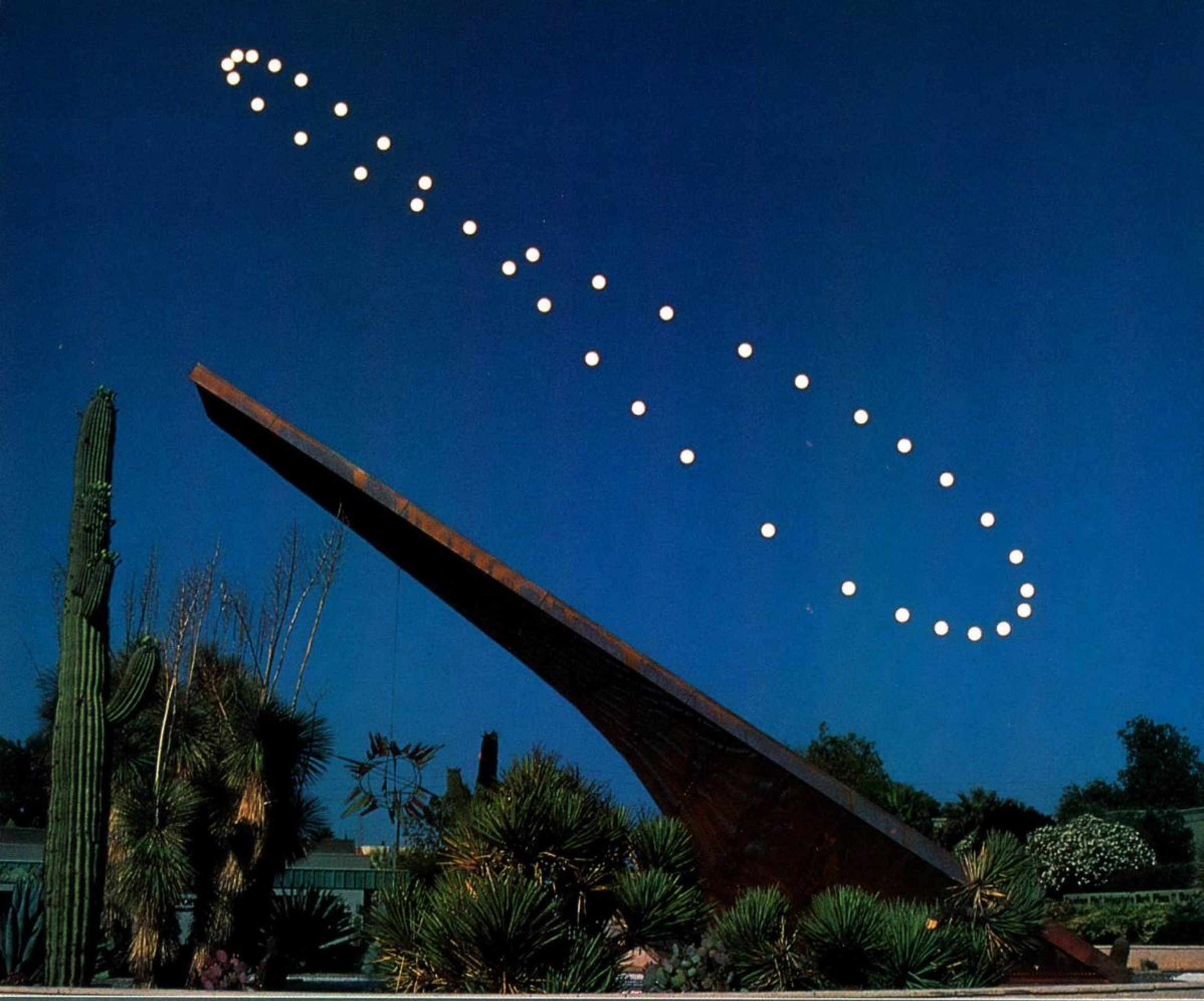
MARS GREW LARGER AS IT NEARED OPPOSITION in early January 1993, when its dark surface markings were easily visible in backyard telescopes. CCD image by Donald C. Parker.

THE SUN NEVER SETS IN CAREFREE

Affix a camera to a sturdy mount, load it with film, and take a photo of the Sun at a particular time of day. Sounds simple enough. Do this regularly throughout a calendar year and you'll end up with a picture of the analemma, the Sun's apparent path in our sky throughout the year. Frank Zullo's analemma picture (opposite page), a composite of 37 separate photos taken from Carefree, Arizona, wins this month's $100 "Best Astrophoto" award.

One of December 1992's solar system events was the close passage of asteroid 4179 Toutatis to Earth. By employing three 15-minute exposures spaced over 105 minutes, Preston S. Justis captured the asteroid's streak against the stars of Cancer (bottom right).

Winter deep-sky objects also attracted astrophotographers. Orion's bright blue, white, and orange stars were captured by Neil A. Dronet, who used a 50mm lens for his 15-minute exposure (bottom far right). Tony Hallas and Daphne Mount captured NGC 6946 in Cepheus (left) using a 14-inch SCT and hypersensitized Fuji Super HG 400 film. In Arizona's Hualapai Mountains George Greaney used a 5-inch refractor at f/5.9 and hypered Fuji Super HG 400 to capture a lovely portrait of the Andromeda Galaxy (below). The image is a print made from two 60-minute exposures.



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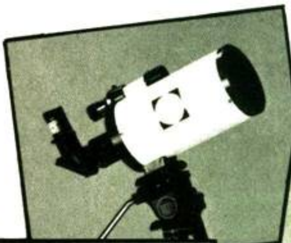

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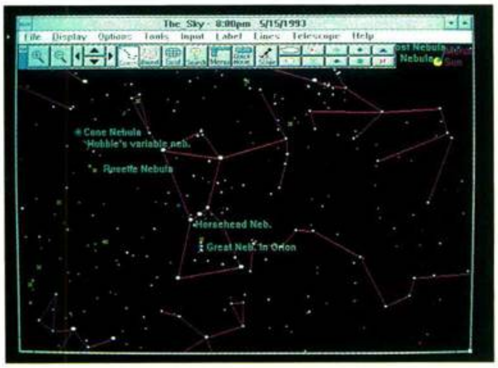

Darla Gawelski

The_Sky (1.04), *Software Bisque, P.O. Box 309, La Verne, CA 91750. Phone (714) 988-5678. Price: Level II: $129; Level III: $199. Minimum requirements: 80286-based computer, 640 KB memory, DOS 3.1, and Windows 3.X. Level II contains over 55,000 objects and requires 5.5 MB of hard-disk space; Level III contains more than 272,000 objects and requires 12 MB of hard-disk space. A mouse and math coprocessor are recommended. Level II is reviewed below.*

The_Sky is filled with features for the backyard astronomer. It provides a Moon-phase calendar, finds eclipses and conjunctions, and displays the motions of the four largest satellites of Jupiter.

Getting to an object is easy with the aid of features called Quick Move and Search. If you know an object's rough position in the sky, you can move a cursor through a grid to that position, and that region of the sky will be plotted. Or you can use the Search command to find a planet, star, constellation, or deep-sky object by name. Searches use "fuzzy logic," so exact spelling isn't needed. For example, "casopea" will find Cassiopeia.

Clicking on an object will display the object's coordinates, magnitude, rise and set times, and altitude and azimuth. The identification box also shows whether one of the 23 images shows the object (you need high-res VGA to see the images in full color). You can also keep an observer's log for the object.

The Smithsonian Astrophysical Observatory star catalog forms the base for the program. Objects from the Messier, NGC, and IC catalogs form the deep-sky database. You can also add comets and asteroids to the solar system database (3 comets and 1 asteroid are included).

Printing star charts is easy because the program uses the Windows interface for printers. But that also limits the quality of the star images. For example, stars don't appear round on an HP LaserJet IIIP printout.

Several different map projections for equatorial (RA and Dec) and horizon (altitude and azimuth) are available so you can customize your sky maps and finder charts.

Although I couldn't test this capability, The_Sky can directly control a telescope. So finding an object is as simple as pointing to it on the screen. Contact Software Bisque for a list of telescopes the program can control.

Calculations of planetary positions are pretty accurate. The positions of Pluto (always a good test) for 1993 were virtually identical to the positions obtained from an ephemeris. Some times of conjunctions and lunar phases were off by up to six hours, but eclipse times appeared good to one minute. Users should note, however, that the positions of the stars are always given in 2000.0 coordinates. The program does not precess these coordinates, so don't use this program to investigate the positions of objects very far into the past or future. This warning also seems to apply to the eclipse finder because it misidentified the total solar eclipse of July 20, 1963, as only a partial eclipse. Eclipse chasers should note also that the finder shows the eclipse regardless of whether it is visible from a particular site.

You'll find many of the constellation figures to be different from traditional portrayals. The identifications for bright stars include common names and SAO number, but no Bayer or Flamsteed designations. Zooming in or out automatically changes the faint-magnitude limit, so some objects appear or disappear as you change the field size. And the positions of objects use **d** for degrees instead of ° and ' and " for minutes and seconds of right ascension instead of **m** and **s**.

If you want one astronomy package that does it all from telescope control to conjunction finding, take a look at The_Sky. It will serve well those backyard astronomers who don't want to shuffle through several different programs to plan and record their observing sessions. — *Dave Bruning*

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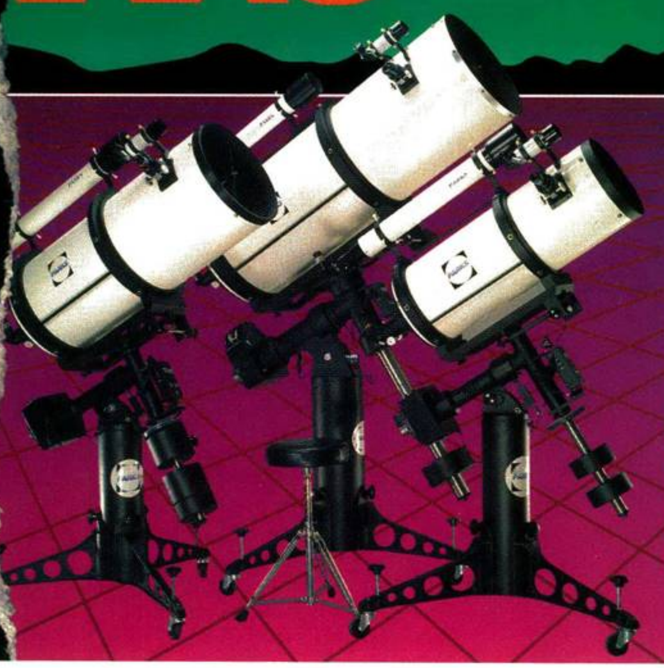

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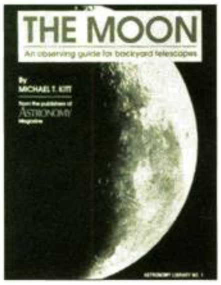
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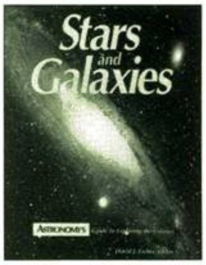

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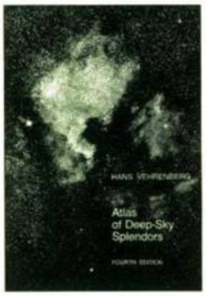

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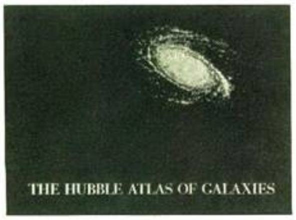

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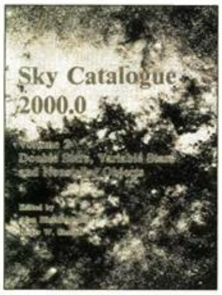

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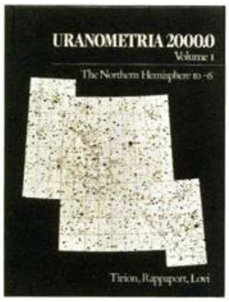

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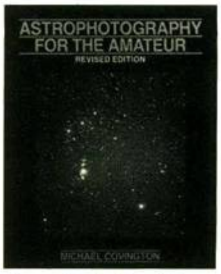

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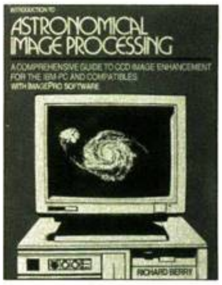
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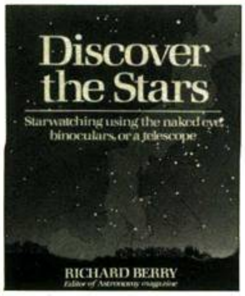
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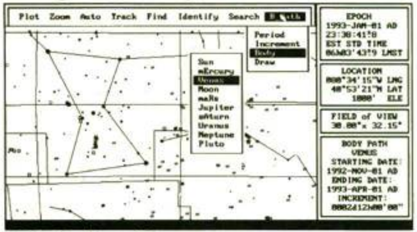

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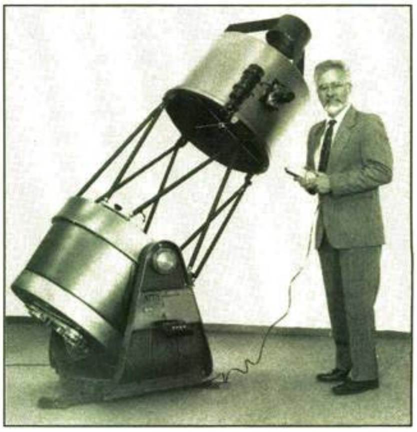
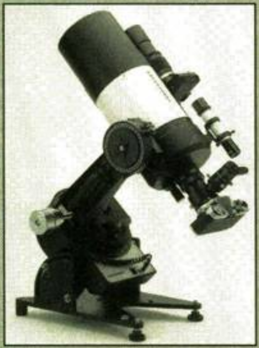


Jim's Mobile Industries (JMI), 1960 County Road 23, Evergreen, CO 80439, (303) 277-0304. $24,900.

2

Celestron Reintroduces the C5

The C5 is a portable 5-inch f/10 Schmidt-Cassegrain telescope available in three versions. The standard C5 features a single-arm fork mount, setting circles, piggyback camera platform, AC motor drive with a re-engineered spur gear mechanism, and tabletop wedge. It includes a 5x24 finderscope, 1.25-inch star diagonal, and 25mm Kellner eyepiece. The C5+ (pictured with optional accessories) offers the same features but has a DC motor drive with an electronic drive corrector and hand controller suitable for long-exposure astrophotography. The tube assembly is also available separately as the C5 Spotting Scope which includes an 8x20 erect-image finder in place of the 5x24 finder.



Celestron International, 2835 Columbia Street, Torrance, CA 90503, (310) 328-9560. C5: $1,478; C5+: $1,798; C5 Spotting Scope: $1,198.

3

A New Magazine for Deep-Sky Observers

Deep Sky Journal is a new bimonthly magazine devoted solely to the field of deep-sky observing and photography. All the material in the journal is written by subscribers, both observers and photographers. The topics focus on finding deep-sky objects and recording observations in notes, sketches, and photographs. Regular columns cover double stars, variable stars, book reviews, and product reports.

Texas Star Party
DEEP SKY JOURNAL #2
AUTUMN 1992

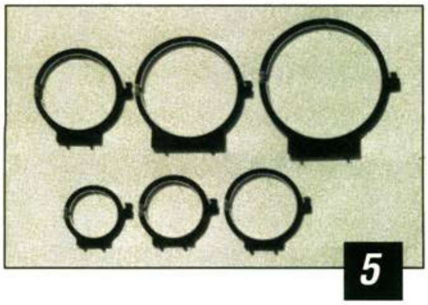
Deep Sky Journal, 6210 Karjala Road, Aberdeen, WA 98520, (206) 532-0711. One-year subscription (6 issues): $24 in the U.S.; for Canada, Mexico, and overseas: $30 in U.S. funds.

This department presents new product announcements issued by their manufacturers. The product information is as supplied by the manufacturers or distributors. All prices are suggested retail. Suppliers are invited to send their product announcements to the attention of Alan Dyer.

4 Connect Your Telescope to Your Computer

StarConnect software allows you to control your Meade LX200 or #1697-equipped Meade LXD600 or LXD700 mount using your PC computer and one of several popular star chart programs. Simply use the mouse to point at any celestial object the star-chart can display, press two shift keys simultaneously, and StarConnect commands the telescope to slew automatically to that object in the real sky. In addition, StarConnect lets you command many of the functions of the LX200 and #1697 systems directly from the computer keyboard. StarConnect will work with EZCosmos, Lodestar, SkyGlobe, StarGaze, and TheSky software packages. StarConnect includes software, an interface cable, and a manual.

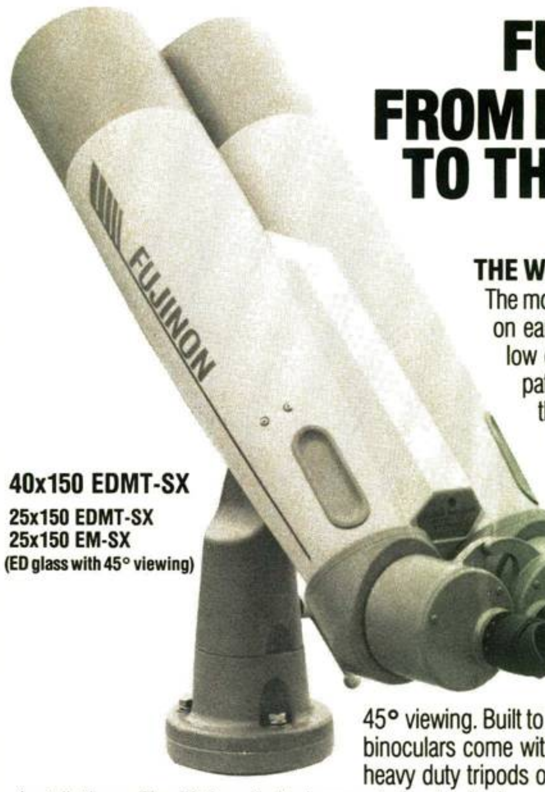
Applied Controls Technology, 8059 Lochdale, Dearborn Heights, MI 48127, (313) 563-6652. $39.95 plus $5 shipping.



Accessory Tube Rings from Parallax

Parallax Instruments, manufacturer of high-resolution Newtonian tube assemblies, now offers cast-aluminum tube mounting rings. All rings are felt-lined and fitted with stainless-steel hinges and fasteners. The black-satin finished rings are available for tubes with 5-inch to 16-inch outside diameters. Ring bases are drilled and tapped to the customer's specifications.

Parallax Instruments, Suite 708, Box 192, 8318 Pineville-Matthews Road, Charlotte, NC 28226, (704) 542-4817. 5", 5.5", 6", or 6.5" O.D.: $89; 7" or 8": $99; 9" or 10": $109; 12": $119; 16": $139. All prices are for a pair of rings. Custom sizes also available. ☐



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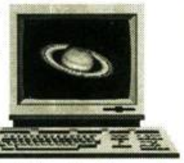
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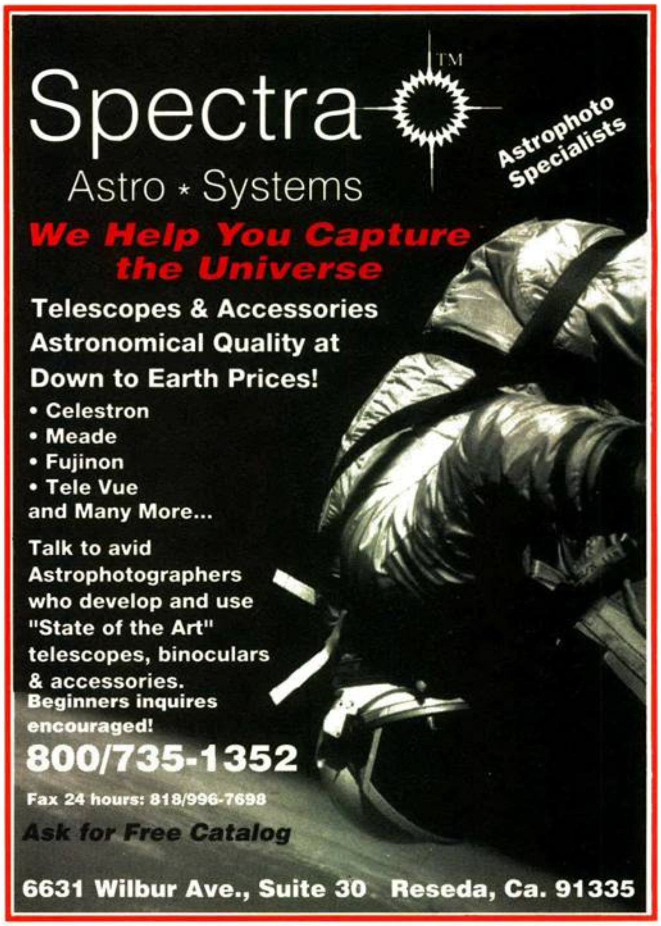

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Aperture	Mounted	Aperture	Unmounted
2.4"	$49.00	2.4"	$39.00
3.1"	52.00	3.1"	42.00
3.5" to 4"	59.00	3.5 to 4"	49.00
4-1/4" to 5"	74.00	4-1/4" to 5"	64.00
6"	79.00	6"	69.00
8"	95.00	8"	85.00
10"	109.00	10"	99.00
11"	119.00	11"	109.00
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14"	169.00	14"	149.00

40mm to 80mm Binoculars - Mounted .... $92.00 pr.

GLASS - *TYPE 2* *(Full Aperture)*

Same as type 1, except stainless steel is combined in the coating to provide an even more durable surface that highly resists wear due to excessive handling and ultraviolet radiation. Solar image is also yellow-orange.

Aperture	Mounted	Aperture	Unmounted
2.4"	$62.00	2.4"	$52.00
3.1"	65.00	3.1"	55.00
3.5" to 4"	76.00	3.5 to 4"	66.00
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Meetings & Events

April 25
Space Memorabilia Swap Meet, Crystal City Holiday Inn (1489 Jefferson-Davis Highway), Virginia. Write to Swap Meet, P.O. Box 604, Glenn Dale, MD 20769. Phone (301) 249-3895.

April 30 and May 1
Astronomy Day, Lemon Lake County Park, Crown Point, Indiana. Sponsored by the Calumet Astronomical Society. Contact: Stephen J. Miller. Phone (219) 845-9174.

May 1
Astronomy Day, several sites including two local college observatories. Sponsored by the North Shore Amateur Astronomy Club. Contact: Paul Graveline. Phone (508) 470-1970.

May 17-23
Invitation to Amateur Radio Operators. Participate in the 1993 Texas Star Party by discussing astronomy subjects over amateur radio stations. The dates, times, and frequencies are 5/18/93 at 9 p.m. on 14.285 MHz (+/-) and 5/19/93 at 9 p.m. on 7.235 MHz (+/-). Special event TSP QSL cards with an astronomical theme will be available by sending a SASE to K5GH-TSP, 2619 Bordeaux, McKinney, TX 75070. Contact: Steve Coleman-WB4GHY, P.O. Box 922, Van Alstyne, TX 75495. Phone (903) 482-6859.

May 21-23
1993 Southern Star Astronomical Convention, Charlotte, North Carolina. Sponsored by the Charlotte Astronomical Society. Contact: Robert White, 9820 White Cascade Drive, Charlotte, NC 28269.

May 22
Spring Star Party, Portsmouth, Virginia. Sponsored by the Tidewater Community College Planetarium Society. Contact R. H. Stewart, 1064 Dune Street, Norfolk, VA 23503.

May 29-31
40th Anniversary Celebration, Museum of Natural History. Write to Cormack Planetarium, Museum of Natural History, Roger Williams Park, Providence, RI 02907-3600 or call Michael Umbricht (401) 785-9457.

June 4-6
82nd Spring Meeting, Berkeley, California. Sponsored by the American Association of Variable Star Observers. Contact: Janet A. Mattei, 25 Birch Street, Cambridge, MA 02138. Phone (617) 354-0484.

June 19-August 28
International Space University Summer Session, Huntsville, Alabama. Sponsored by the University of Alabama in Huntsville. Write to International Space University, 955 Massachusetts Avenue, Cambridge, MA 02139.

June 25-July 2
Kopernik Astronomical Society Trip, Kitt Peak, Lowell Observatory, Meteor Crater, and Grand Canyon. Sponsored by the Kopernik Astronomical Society. Write to Kopernik Observatory, 30 Front Street, Binghamton, NY 13905 or call Jay Sarton (607) 772-0660.

July 12-21
Space Week, Goodwood Library, Baton Rouge, Louisiana. Sponsored by the Baton Rouge Astronomical Society, Inc. Contact: Craig Brenden, 6348 Double Tree Court, Baton Rouge, LA 70817. Phone (504) 751-1685.

August 7-11
The Asimov Seminar, Rensselaerville Institute, Rensselaerville, New York. This year's topic is First Contact: The Human Impact. Write to The Asimov Seminar, The Rensselaerville Institute, Rensselaerville, NY 12147, or call Don McGrain (609) 3732.

August 30-September 3
8th General Assembly of the IUAA and the **1st General Assembly of the European Section of the IUAA**, Wolverhampton, England (about 19 km west of Birmingham). Sponsored by the Wolverhampton Astronomical Society. Contact: M. Astley, Secretary, Wolverhampton Astronomical Society, "Garwick" 8 Holme Mill, Fordhouses, Wolverhampton, West Midlands WV10 6LZ.

September 23-26
International Meteor Conference, Puimichel, Haute-Provence, France. Organized by the International Meteor Organization. Contact: Paul Roggemans, Pijnboomstraat 25, B-2800 Mechelen, Belgium. □

Clubs, please submit announcements at least four months before the date of the meeting or event. Readers, when you write to organizations listed in Meetings and Events, include a self-addressed, legal-sized envelope with your request for information.

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Satellites, edited by Joseph A. Burns and Mildred Shapley Matthews (University of Arizona Press, 1986). A technical survey of all the satellites of the solar system, including a 60-page chapter devoted to Io.

Satellites of the Outer Planets, by David A. Rothery (Oxford University Press, 1992). An excellent, up-to-date survey geared toward advanced lay readers.

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A Manual of Advanced Celestial Photography, by Brad D. Wallis and Robert W. Provin, (Cambridge University Press, 1988). Two experienced astrophotographers provide their technical and detailed advice on advanced techniques such as hypering.

"The Secrets of My Astrophotography Success" by Kim Zussman, ASTRONOMY, June 1989. The author discusses his equipment and techniques for acquiring sharp deep-sky images.

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Telescope Optics, by Harrie Rutten and Martin van Venrooij, (Willman-Bell, 1988). Detailed information about the optical design of Schmidt cameras.

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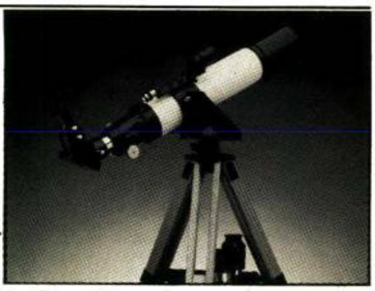

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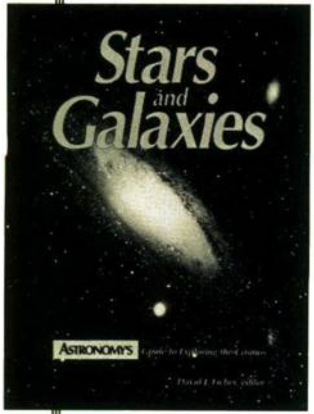

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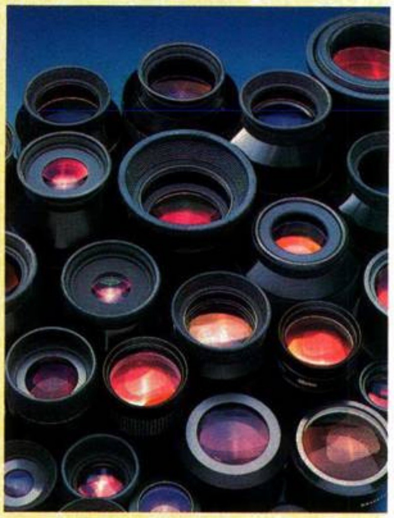

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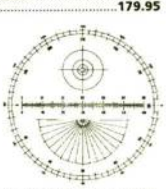

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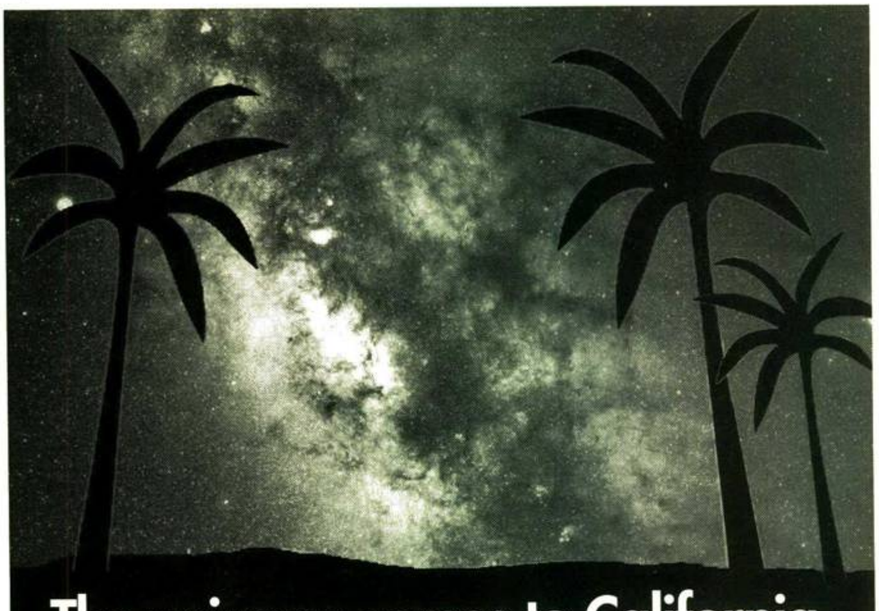

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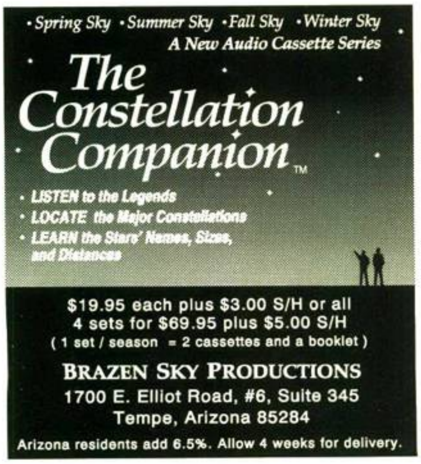

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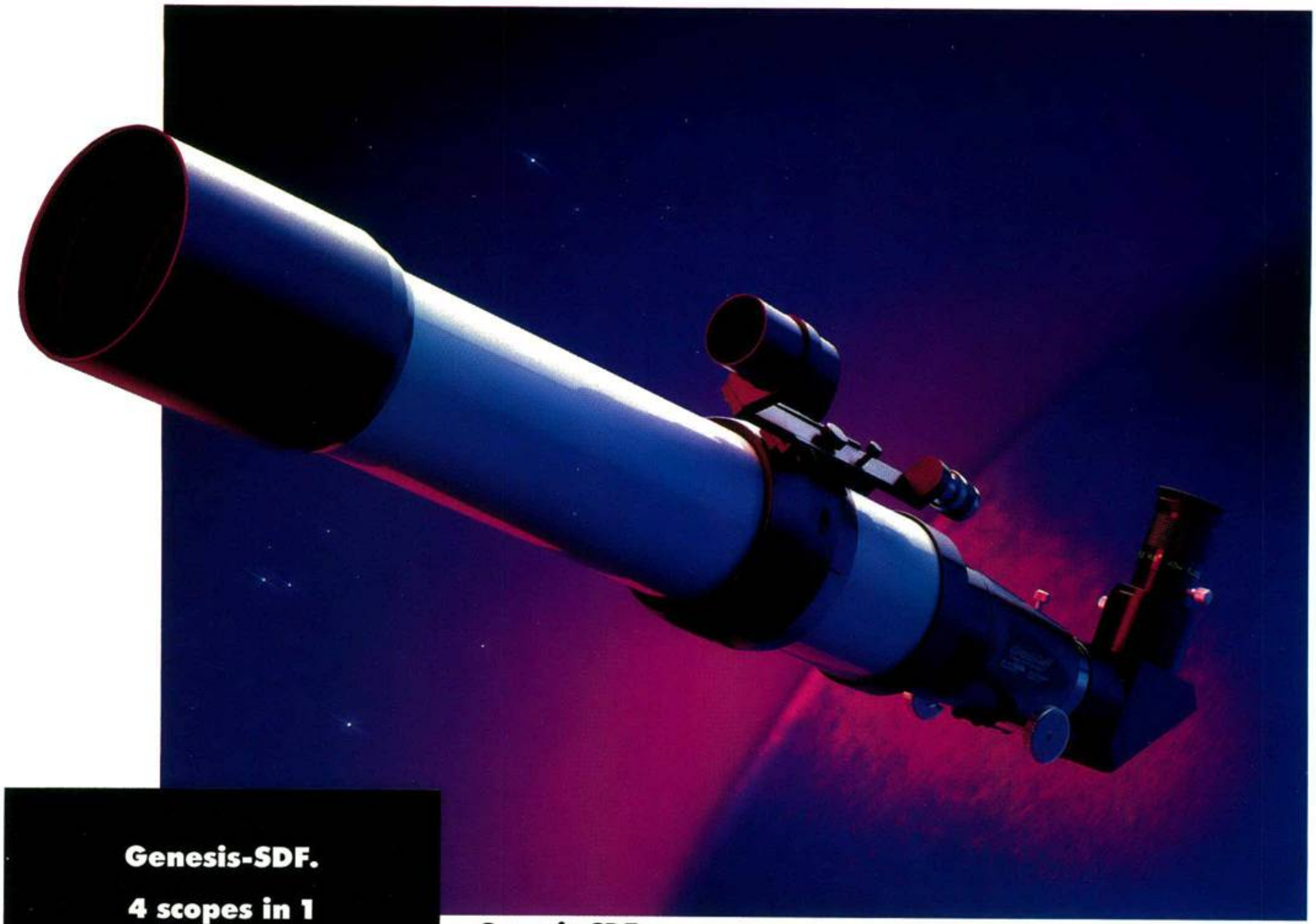

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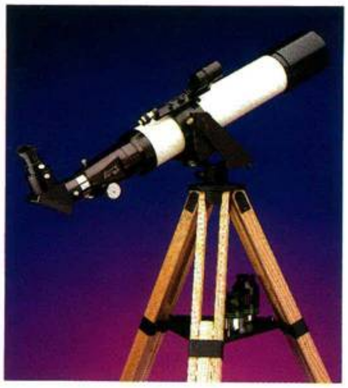

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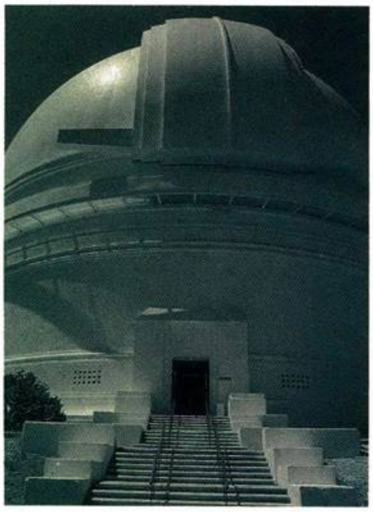

Your guide to

North America's

astronomy clubs,

organizations,

planetariums,

and observatories.

Supplement to ASTRONOMY magazine

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ASTRONOMY PLACES

Whether you're looking for places to visit while you're on vacation or a source of information on things astronomical, our list of astronomy facilities should help you out. Our compilation contains nearly 500 planetariums, observatories, nature centers, and science centers. For planetariums that supplied the information, we have indicated the diameter of the domed theater and the type of star projector used (Digistar, Minolta, Spitz, Zeiss, etc.). For public observatories, we have indicated the size and type of the main telescope. We have also listed other features such as IMAX® theaters and exhibit galleries as well as indicated operating hours.

If your local facility is not included in our list, please contact us so we can update our database.

UNITED STATES

ALABAMA

Birmingham: Robert R. Meyer Planetarium, Birmingham Southern College, Box A-36, 35254, (205) 226-4770, 30' dome theater (Spitz A3P). Open daily.

Florence: Planetarium and Observatory, Univ. of North Alabama, Pine St., 35632, (205) 760-4284, 30' dome theater (Spitz A3P), observatory (14.5" Newtonian). Open by reservation. Not open July and Aug. Program info. line: 760-4334.

Huntsville: The Space and Rocket Center, One Tranquility Base, 35807, (205) 837-3400, OMNIMAX® theater, visitor center for the Marshall Space Flight Center. Open daily.

Jacksonville: Jacksonville State University Planetarium, North Pelham Rd., 36265, (205) 782-5616, 20' dome theater, observatory (12.5" scope). Open by reservation.

ALASKA

Fairbanks: Geophysical Institute, Univ. of Alaska-Fairbanks, Elvey Building, 99775.

ARIZONA

Amado: Multiple Mirror Telescope Observatory, Fred Lawrence Whipple Observatory, P.O. Box 97, 85645, (602) 670-6741. Tours by reservation only.

Flagstaff: Braeside Observatory, U.S. Naval Observatory Road, P.O. Box 906, 86002, (602) 774-4222, observatory (16" Cassegrain), photoelectric photometry. Open by reservation.

Flagstaff: Lowell Observatory, 1400 W. Mars Hill Rd., 86001, (602) 774-3358, observatory (24" refractor), exhibits, tours. Open daily except Mon. and Tues. Dec. - April. Program info. line: 774-2096.

Flagstaff: Northern Arizona Univ. Campus Observatory, Dept. of Physics and Astronomy, Box 6010, 86011-6010, (602) 523-2661, observatory (24" reflector), exhibits, tours. Open Thurs. night and also by reservation.

Flagstaff: U.S. Naval Observatory, P.O. Box 1149, 86002, (602) 527-7000.

Tucson: Flandrau Planetarium, Univ. of Arizona, Corner of Cherry and University Blvd., 85726, (602) 621-4515, 50' dome theater (Minolta IV), observatory (16" reflector), Cinema 360°, science museum. Open daily. Program info. line: 621-STAR.

Tucson: Kitt Peak National Observatory, P.O. Box 26732, 85726-6732, (602) 322-3426. Largest telescope is 4-meter Mayall. Visitor center at summit, 16" reflector, exhibits, tours, lectures, films. Open daily except Thanksgiving, Christmas, and New Year's Day. Program info. line: 322-3350.

Tucson: Steward Observatory, Univ. of Arizona, 85721, (602) 621-2288.

ARKANSAS

Fayetteville: Univ. of Arkansas Planetarium, 117 Physics Building, 72701, (501) 575-2506, 20' dome theater (Spitz A1), observatory (16" Cassegrain). Not open in summer. Open by reservation.

Little Rock: Univ. of Arkansas-Little Rock Planetarium, 2801 South University Ave., 72204, (501) 569-3259, 40' dome theater (Minolta Series II B), observatory (14.5" Cassegrain). Open Fri. at 7:30 p.m. and Sun. at 2:30 p.m. only. Program info. line: 569-3277.

CALIFORNIA

Apple Valley: Apple Valley Science and Technology Center, 15552 Wichita Rd., 92309, (619) 242-4115.

Aptos: Cabrillo College Planetarium, 6500 Soquel Dr., 95003, (408) 688-6466.

Berkeley: Lawrence Hall of Science, Univ. of California, 94720, (510) 642-5362, 23' dome theater (Goto Mercury), observatory (various scopes). Open daily except major holidays. Program info. line: 642-5133.

Big Bear City: Big Bear Solar Observatory, 40386 North Shore Lane, 92314, (909) 866-5791, tours. Open Sat. 4 to 6 p.m. during summer.

Cassel: Hat Creek Radio Observatory, Univ. of California, Berkeley, Rt. 2, Box 500, 96016, (916) 335-2364, 85' dish and three 20' dishes. Open Mon. - Fri.

Chula Vista: Southwestern College Planetarium, 900 Otay Lakes Rd., 91910, (714) 421-6700, 30' dome theater, observatory (12" scope). Open by reservation.

Cupertino: De Anza Minolta Planetarium, 21250 Stevens Creek Blvd., 95014, (408) 864-8814, 50' dome theater (Minolta), exhibits, tours, laser shows. Open daily.

Edwards: NASA, Hugh L. Dryden Flight Research Facility, P.O. Box 273, 93523, (805) 258-3460, visitor center. Open 7:45 a.m. - 3:45 p.m. weekdays. Tours at 10:15 and 1:15.

Eureka: College of the Redwoods Planetarium, Tompkins Hill Rd., 95501, (707) 445-6831, 14' dome theater, observatory (14" scope). Not open in summer.

Fresno: Discovery Center, 1944 North Winery Ave., 93703, (209) 255-5533, public observing Fri. evenings in summer. Open Tues. - Fri.

Hayward: Chabot College Planetarium, 25555 Hesperian Blvd., 94545, (510) 786-6881, 30' dome theater (Spitz A3P). Open for classes only.

Los Altos: Foothill College Observatory, Foothill College, 12345 El Monte Road, 94005, (415) 949-7334, observatory (16" Newtonian and 6" refractor). Open every clear Fri. 8:30 p.m. to 11:00 p.m., Sat. 10:00 a.m. to noon, and by reservation.

Los Angeles: California Museum of Science and Industry, Exposition Park, 700 State Dr., 90037, (213) 744-7483, exhibits, IMAX® theater. Open daily.

Los Angeles: Griffith Observatory, 2800 East Observatory Rd., 90027, (213) 664-1191, 75' dome theater (Zeiss Mark IV), observatory (12" Zeiss refractor), laser shows, exhibits, tours. Open Tues. - Sun. Not open Thanksgiving or Christmas. Program info. line: 664-1181.

Moffett Field: NASA Ames Research Center, Mail Stop TO-27, 94035, (415) 604-6497, exhibits, tours by reservation. Open Mon. - Fri. 9 a.m. - 4:30 p.m.

Mount Hamilton: Lick Observatory, P.O. Box 55, 95140, (408) 274-5062, 120" and 40" reflectors, 36" refractor. Open daily, daytime only. Public observing through 40" and 36" on Friday nights July 6 - Aug. 31 by reservation only.

Oakland: Chabot Observatory and Planetarium, 4917 Mountain Blvd., 94619, (415) 531-4560, 30' dome theater, 20" refractor, exhibits. Open Fri. and Sat. evenings.

Owens Valley: Owens Valley Radio Observatory, Robinson Laboratory, California Institute of Technology, Pasadena, 91125, (818) 356-4912.

Pasadena: Mount Wilson Observatory, Mount Wilson Institute, 740 Holladay Rd., 91106, (818) 793-3100, historic 100" and 60" reflectors.

Pasadena: NASA Jet Propulsion Laboratory, 4800 Oak Grove, 91109, (818) 354-8593. Open 10 a.m. - 3 p.m. weekdays by appointment only.

Pasadena: Palomar Observatory, California Inst. of Technology, 91125, (619) 742-2119, 200" Hale telescope. Open daily in summer, daytime only.

Pleasant Hill: Diablo Valley College Planetarium, Astronomy Dept., 321 Golf Club Rd., 94523, (510) 685-1230, 24' dome theater (Spitz A3P), observatory (18" Cassegrain). Open by reservation.

Redding: Schreder Planetarium, Shasta County Office of Education, 1644 Magnolia Ave., 96001-1599, (916) 225-0275, 33' dome theater (Minolta II-B). Open for school groups Tues., Wed., and Thurs. by reservation. Not open in summer. Program info. line: 225-0251.

Rohnert Park: Sonoma State Univ. Observatory, Dept. of Physics and Astronomy, 94928, (707) 664-2119, 14" scope. Open one evening per month. Program info. line: 664-2267.

Sacramento: Sacramento Science Center, 3615 Auburn Blvd., 95821, (916) 277-6180, 30' dome theater (Spitz A3P), exhibits. Open Wed. - Sun. Program info. line: 485-8836.

San Bernardino: San Bernardino Valley College Planetarium, 701 South Mt. Vernon Ave., 92410, (909) 888-6511 x1443, 33' dome theater (Goto G10), observatory (16" reflector). Open by reservation. Program info. line: 888-6511 x1459.

San Diego: Mount Laguna Observatory, Dept. of Astronomy, San Diego State Univ., 92182, (619) 594-6182, 20' dome theater (Spitz), observatory (21" Cassegrain). Observatory open Fri. and Sat. nights during summer; planetarium open by reservation.

San Diego: Reuben H. Fleet Space Theater and Science Center, 1875 El Prado, Balboa Park, 92101, (619) 238-1233, 76' dome theater with planetarium shows, laser shows, OMNIMAX® films. Open daily.

San Diego: San Diego Aerospace Museum, 2001 Pan American Plaza, Balboa Park, 92101, (619) 234-8291, exhibits, tours. Open daily except Thanksgiving, Christmas, and New Year's.

San Francisco: Exploratorium, 3601 Lyon St., 94123, (415) 563-7337, extensive science exhibits. Open daily except Mon.

San Francisco: Morrison Planetarium, California Academy of Sciences, Golden Gate Park, 94118, (415) 750-7127, 65' dome theater, laser shows, exhibits. Open daily in summer. Program info. line: 750-7141.

San Jose: Rosicrucian Planetarium and Science Center, Rosicrucian Park, 1342 Nagler Ave., 95191-0001, (408) 947-3640, 50' dome theater (Spitz 512), exhibits, tours. Open daily. Program info. line: 947-3636.

San Marcos: Palomar College Planetarium, 1140 W. Mission Rd., 92069, (619) 744-1150, 30' dome theater (Spitz A3P), exhibits, observatory (14" SCT). Not open in summer.

Santa Barbara: Gladwin Planetarium/Palmer Observatory, Santa Barbara Museum of Natural History, 2559 Puesta del Sol Rd., 93105, (805) 682-4711, 24' dome theater (Spitz A3P), observatory (29" reflector), exhibits, tours. Open daily noon - 4 p.m.

Santa Monica: Santa Monica College Planetarium, 1900 Pico Blvd., 90405, (805) 682-4711 x326, 28' dome theater (Minolta MS8), observatory (10" SCT). Open Friday evenings and by reservation.

Santa Rosa: Santa Rosa Junior College Planetarium, 1501 Mendocino Ave., 95401, (707) 527-4640, 40' dome theater (Goto SG12). Not open in summer. Program info. line: 527-4371.

Saratoga: West Valley College Planetarium, 14000 Fruitvale Ave., 95070, (408) 867-2200, 30' dome theater (Spitz A4). Open daily.

Stockton: Clever Planetarium and Earth Science Center, San Joaquin Delta College, 5151 Pacific Ave., 95207, (209) 474-5051, 33' dome theater (Spitz 512), Cinema 360°, exhibits. Open weekends. Program info. line: 474-5110.

Walnut: Mt. San Antonio College Planetarium, 1100 North Grand Ave., 91789, (714) 594-5611.

COLORADO

Alamosa: Harry Zacheis Planetarium, Adams State College, 81102, (719) 589-7616, planetarium (Spitz P3A), observatory (12.5"-17.5" scopes). Open by reservation.

Boulder: Fiske Planetarium and Science Center, Univ. of Colorado, Regest Dr., 80309-0408, (303) 492-5002, 65' dome theater (Zeiss VI), observatory (16" and 18" Cassegrains), exhibits. Open daily in summer except for Sat. and Sun. Program info. line: 492-5001.

Boulder: National Center for Atmospheric Research (NCAR), P.O. Box 3000, 80307, (303) 497-1173, exhibits, tours, and printed materials offered. Open daily. Program info. line: 497-1174.

Colorado Springs: Black Forest Observatory, 12815 Porcupine Lane, 80908, (719) 495-3828, observatory (30" Cassegrain), tours. Open by reservation.

Colorado Springs: U.S. Air Force Academy Planetarium, Center for Educational Multimedia, 5Oh ATS/DOP, 80840, (719) 472-2779, 50' dome theater (Digistar). Open Mon., Wed., and Fri. 3:30 p.m. during academic year; open Tues. - Sun. during summer. Program info. line: 472-2778.

Denver: Chamberlin Observatory, Univ. of Denver, Dept. of Physics, 80208, (303) 871-2238, observatory (20" refractor), tours, star parties. Public observing Tues. and Thurs. evenings by reservation only.

Denver: Gates Planetarium, Denver Museum of Natural History, 2001 Colorado Blvd., 80205, (303) 370-6317, 50' dome theater (Minolta Series IV), observatory (22" scope), IMAX®, laser shows, exhibits, tours. Open daily in summer. Program info. line: 370-6351.

CONNECTICUT

Avon: Talcott Mountain Science Center, Montevideo Rd., 06001, (203) 677-8571, observatory with 12" reflector. Open year round to the public by appointment.

Danbury: Western Connecticut State College Planetarium, 181 White Street, 06810, (203) 797-4215, 26' dome theater (Spitz AZ376), various scopes. Planetarium open by reservation; public observing open first and third Fri.

Middletown: Van Vleck Observatory, Wesleyan Univ., 06457, (203) 347-9411. Not open in summer.

Mystic: Mystic Seaport Museum and Planetarium, P.O. Box 6000, Greenmanville Ave., 06355, (203) 572-0711, 30' dome theater, public observing. Open daily in summer.

New Britain: Copernican Observatory and Planetarium, Central Connecticut State Univ., Wells St., 06050, (203) 827-7852. Open Fri. and Sat. evenings only.

New Haven: Southern Conn. State Univ. Planetarium, Fitch and Pine Rock streets, 06515, (203) 397-4351, 24' dome theater, observatory (12" scope). Open by reservation. Not open in summer.

Stamford: Stamford Museum and Nature Center, 39 Scofieldtown Rd., 06903, (203) 322-1646, 23' dome theater (Spitz A1), observatory (22" scope), exhibits, tours. Open daily except Christmas and New Year's Day.

Storrs: Univ. of Connecticut Planetarium, Physics Dept. U-46, 2152 Hillside Rd., 06269, (203) 486-4915, 16' dome theater, observatory (6" refractor and 8" reflector). Open by reservation.

West Hartford: Grengas Planetarium, Science Museum of Connecticut, 950 Trout Brook Dr., 06119, (203) 236-2961.

Willimantic: Robert K. Wickware Planetarium, Eastern Conn. State College, 83 Windham St., 06226, (203) 456-5300, 30' dome theater (Spitz A4). Open by reservation only. Not open in summer.

DELAWARE

Greenville: Mr. Cuba Astronomical Observatory, Inc. P.O. Box 3915, Hillside Mill Road, 19807, (302) 654-6407, 20' dome theater (Nova III), observatory (24" refractor), tours. Open by reservation only.

DISTRICT OF COLUMBIA

Washington: National Air and Space Museum, Albert Einstein Planetarium, 6th St. and Independence Ave. SW, MRC 313 Smithsonian Institution, 20560, (202) 357-1529, 70' dome theater (Zeiss VIa), IMAX®, exhibits, tours. Open daily except Christmas. Program info. line: 357-2700.

Washington: Rock Creek Nature Center, 5200 Glover Rd. NW, 20015, (202) 426-6829, 24' dome theater (Spitz A4). Open daily.

Washington: U.S. Naval Observatory, 34th and Massachusetts Ave. NW, 20392, (202) 653-1543, 26" and 12" Clark refractors. Open Mon. evenings only except federal holidays.

FLORIDA

Bradenton: Bishop Planetarium, 201 10th St. West, 34205, (813) 746-4131, 50' dome theater (Spitz STP), observatory (6" refractor), laser shows, exhibits, tours. Open daily in summer except Mon. Program info. line: 746-STAR.

Cocoa: Astronaut Memorial Space Science Center, Brevard Community College, 1519 Clearlake Rd., 32922, (407) 631-7889, 40' dome theater, observatory (24" Cassegrain), Cinema 360°, laser shows, exhibits. Public viewing Fri. and Sat.

Daytona Beach: Museum of Arts and Sciences Planetarium, 1040 Museum Blvd., 32114, (904) 255-0285, 40' dome theater (Minolta MS10). Open Tues. - Sun.

Ft. Lauderdale: Buehler Planetarium, Broward Community College, 3501 Southwest Davie Rd., Davie, 33314, (305) 475-6681, 40' dome theater (Zeiss M1015), 16' dome theater (Goto), observatory (10" scope), laser shows, exhibits, star lab. Program info. line: 475-6680.

Ft. Myers: Junior Museum and Planetarium, 3450 Ortiz Ave., 33906, (813) 275-3435, 40' dome theater (Spitz 512), Cinema 360°. Open daily. Public observing Nov. - April. Program info. line: 275-3183.

Gainesville: Observatory, Univ. of Florida, 211 SSRB, Dept. of Astronomy, 32611, (904) 392-2052, observatory (12" reflector and 8" refractor), tours. Open Fri. evenings during academic year.

Jacksonville: Alexander Brest Planetarium, Jacksonville Museum of Sciences and History, 1025 Museum Circle, 32207-9053, (904) 396-7061 x261, 60' dome theater (Jena RFP-DP3), exhibits, tours. Open daily except Thanksgiving and Christmas. Program info. line: 396-7061 x4.

Kennedy Space Center: Kennedy Space Center Spaceport USA, Mail Code TWRS, 32899, (407) 452-2121, IMAX® theater, exhibits, tours. Open daily.

Melbourne: Space Coast Science Center, 1510 Highland Ave., P.O. Box 36-1816, 32936, (407) 259-5572, Open Tues. - Sat.

Miami: Miami Space Transit Planetarium, 3280 South Miami Ave., 33129, (305) 854-4242, 65' dome theater (Spitz STP), observatory (17.5" reflector), exhibits. Open daily except Thanksgiving and Christmas. Program info. line: 854-2222.

North Fort Myers: Milky Way Productions, (813) 368-6106. Conducts star parties for groups and schools by reservation.

Orlando: John Young Planetarium, Orlando Science Center, 810 East Rollins St., 32803, (407) 896-7151, 40' dome theater (Minolta MS10), observatory (14" scope plus others). Open daily except for Thanksgiving and Christmas.

Pensacola: Owens Planetarium, Pensacola Junior College, 1000 College Blvd., 32504, (904) 484-2054, 30' dome theater. Open Thurs. evenings, Sept. - April only.

St. Augustine: Fountain of Youth Planetarium, 155 Magnolia Ave., 32084, (904) 829-6138, 30' dome theater. Open daily.

St. Petersburg: St. Petersburg Junior College Planetarium, P.O. Box 13489, 5th Ave. North at 69th St., 33710, (813) 341-4320, 24' dome theater, observatory. Open Fri. evenings only.

St. Petersburg: Science Center of Pinellas Co. Planetarium, 7701 22nd Ave. North, 33710, (813) 384-0027, 16' dome theater. Open by reservation.

Tallahassee: Observatory, Dept. of Physics, Florida A&M Univ., 14" scope.

Tallahassee: Pat Thomas Planetarium, Florida State Univ., Dept. of Physics B-159, 32306, (904) 644-6822, 30' dome theater (Spitz 512). Open by reservation. Not open in summer.

Titusville: U. S. Astronaut Hall of Fame, Kennedy Space Center, 32780, (407) 269-6100.

West Palm Beach: Aldrin Planetarium and Gibson Observatory, South Florida Science Museum, 4801 Dreher Trail North, 33405, (407) 832-1988, 30' dome theater (Spitz A3P), observatory (11" SCT), exhibits. Open daily except Thanksgiving and Christmas Day. Program info. line: 832-1988 x600.

GEORGIA

Albany: Wetherbee Planetarium, 100 Roosevelt Rd., 31701, (912) 435-1572, 20' dome theater (Spitz A3P), exhibits. Open daily.

Atlanta: Fernbank Science Center, Jim Cherry Memorial Planetarium, 156 Heaton Park Dr. NE, 30307, (404) 378-4311, 70' dome theater (Zeiss IV), observatory (36" Cassegrain), IMAX®, exhibits. Open daily except some holidays.

Columbus: Patterson Planetarium, 2900 Woodruff Farm Rd., 31907, (404) 568-1730, 40' dome theater. Open by reservation. Public observing weekly at Pine Mountain.

Dahlonega: North Georgia College, Physics Dept., 30597, (706) 864-1511, 30' dome theater (Spitz 512), observatory (16" Cassegrain). Open Fri. evenings and by reservation. Program info. line: 864-1470.

Decatur: Agnes Scott College Planetarium/Bradley Observatory, Agnes Scott College, 30030, (404) 371-6265, 12' dome theater (MMI), observatory (14" SCT). Open first Fri. each month by reservation only. Not open in summer. Program info. line: 371-6266.

Fairmount: Sunrise Planetarium and Science Museum, Camp Sunrise, 1427 Slate Mine Rd. SE, 30139-2835, (706) 337-2776, 35' dome theater (Goto Viewlex), exhibits. Planetarium open by reservation only.

Macon: Museum of Arts and Sciences, 4182 Forsyth Rd., 31210-4806, (912) 477-3232, 40' dome planetarium (Minolta MS10), observatory (10" and 14" scopes), exhibits. Open daily.

Rock Spring: Walker County Science Center, P.O. Box 10, Highway 95, 30739, (404) 764-1111, 24' dome theater (Spitz A3P), observatory (11" SCT). Open by reservation.

Savannah: Savannah Science Museum, 4405 Paulsen St., 31405, (912) 355-6705, 24' dome theater (A3P), exhibits, tours. Open daily except Mon. and holidays.

Statesboro: Georgia Southern Univ. Planetarium, Box 8031, 30460, (912) 681-5292, 40' dome theater. Not open in summer.

Valdosta: Valdosta State College Planetarium, Dept. of Physics, Astronomy, and Geology, 31698, (912) 333-5752, 24' dome theater (Spitz A3P), observatory (16" Cassegrain), exhibits. Open Mon. - Fri. by reservation only. Not open in summer.

Young Harris: Rollins Planetarium, Young Harris College, 30582, (404) 379-3990. Open Fri.

HAWAII

Hilo: Mauna Kea Observatory, Onizuka Center for International Astronomy, 177 Makaala St., 96720, (808) 935-3371, observatory (11" SCT), exhibits, tours, AV programs. Public info. night and star gazing every Fri. and Sat. Program info. line: 961-2180.

Honolulu: Bishop Museum and Planetarium, 1525 Bernice St., P.O. Box 19000-A, 96817, (808) 848-4102, 30' dome theater, exhibits, observatory (12" scope). Open daily. Program info. line: 848-4136.

Honolulu: Mauna Kea Observatories, Institute for Astronomy, 2680 Woodlawn Dr., 96822, (808) 948-8312. Four-wheel drive vehicle recommended for drive to the summit of Mauna Kea on the Big Island. Visitor center at 9,000-foot level.

Mauna Kea: Canada-France-Hawaii telescope, P.O. Box 1597, Kamuela, 96743, (808) 885-7944, 3.6-meter scope. Viewing gallery.

IDAHO

Caldwell: Whettenberger Planetarium, College of Idaho, 2112 Cleveland, 83605, (208) 459-5011. Open by reservation.

ILLINOIS

Bloomington: Observatory, Illinois Wesleyan Univ., 61702, (309) 556-3060, observatory (16" Cassegrain). Open by reservation.

Champaign: William M. Staerkel Planetarium, Parkland College, 2400 W. Bradley Ave., 61821, (217) 351-2568, 50' dome theater (Zeiss M1015), 8" SCT, Cinema 360°, public observing. Open Mon. - Thurs. and Sat. during summer. Program info. line: 351-2446.

Chicago: Adler Planetarium, 1300 South Lake Shore Dr., 60605, (312) 322-0304, 68' dome theater, exhibits, observatory (20" scope with CCD). Open daily in summer.

Chicago: Museum of Science and Industry and Crown Space Center, 57th St. and Lake Shore Dr., 60637, (312) 684-1414, OMNIMAX® theater, exhibits. Open daily except Christmas.

Evanston: Dearborn Observatory, Northwestern Univ., 2131 Sheridan Rd., 60201, (708) 256-6639, 18" scope. Public observing Fri. evenings only by reservation.

Joliet: Herbert Trackman Planetarium, Joliet Junior College, 1216 Houbolt Ave., 60436, (815) 729-9020. Not open in summer.

Kankakee: Strickler Planetarium, Olivet Nazarene Univ., 60901, (815) 939-5395, 30' dome theater (Spitz A4). Open by reservation.

Normal: Illinois State Univ. Planetarium, College Ave. and School St., 61761-6901, (309) 438-8756, 30' dome theater (Spitz A3P). Public shows Fri. and Sat. Open by reservation Mon. - Thurs. Program info. line: 438-2496.

Peoria: Lakeview Museum of Arts and Sciences, 1125 West Lake Ave., 61614, (309) 686-7000, 33' dome planetarium (Spitz 512), exhibits, tours. Program info. line: 686-NOVA.

River Grove: Cernan Earth and Space Center, Triton College, 2000 Fifth Ave., 60171, (708) 456-0300 x372, 44' dome theater (Spitz 512), Cinema 360°, monthly public observing, exhibits. Open Mon. - Sat. Program info. line: 456-5815.

Rockford: Discovery Center Museum, 711 North Main St., 61103-6903, (815) 963-6769, 20' dome theater (Spitz Nova II), exhibits, tours. Open daily in summer.

Rockford: Time Museum, 7801 East State St., 61108, (815) 398-6000 x2943, extensive exhibits of historic timekeeping pieces, tours, films. Open Tues. - Sun.

Urbana: Univ. of Illinois Observatory, 103 Astronomy Building, 1002 W. Green Street., 61801, (217) 328-8198, observatory (12" refractor), exhibits, tours. Open first Fri. each month and by reservation. Not open in summer.

INDIANA

Bloomington: Kirkwood Observatory, Indiana Univ., 47401, (812) 855-6911, 12" refractor. Open Wed. at dusk between Mar. 21 and Sept. 21. Planetarium open by reservation.

Evansville: Koch Science Center and Planetarium,

ASTRONOMY PLACES

Evansville Museum, 411 SE Riverside Dr., 47713, (812) 425-2406, 30' dome theater (Spitz 512), exhibits. Open Tues. - Sun.

Evansville: Wahnseidler Observatory, P.O. Box 3474, 47733, (812) 922-5681, 14" scope. Located in Lynnville City Park. Public viewing each Wed. and third Fri.

Fort Wayne: E. C. Schouweiler Planetarium, Saint Francis College, 2701 Spring St., 46806, (219) 434-3278, 35' dome theater (Spitz A4). Not open in summer. Star of Mexico July 5-15.

Greencastle: McKim Observatory, DePauw Univ., 46135, (317) 658-4654, 9.5" refractor. Open by reservation. Program info. line: 658-4661.

Indianapolis: Holcomb Observatory and Planetarium, Butler Univ., 4600 Sunset Ave., 46208, (317) 283-9282, 24' dome theater (Spitz A3P), observatory (38" Cassegrain), exhibits, tours. Open weekends. Program info. line: 283-9333.

Indianapolis: Spacequest Planetarium, Children's Museum of Indianapolis, 3000 North Meridian St., 46208, (317) 924-5431, 40' dome theater (Digistar), exhibits. Open daily in summer.

Marshall: Nature Center Planetarium, Turkey Run State Park, RR 1, Box 164, 47859-9764, (317) 597-2635, 16' dome theater (Spitz Nova III). Open daily in summer. Program info. line: 597-2654.

Muncie: Ball State Univ. Planetarium, Cooper Science Bldg., 47306, (317) 285-8871, 30' dome theater (Spitz A3P), observatory (many scopes). Open by reservation.

N. Manchester: Manchester College, 46962, observatory (10" reflector). Open Tues. and Thurs. evenings.

Terre Haute: John C. Hook Memorial Observatory, Dept. of Geology and Geography, Indiana State Univ., 47802, (812) 237-6300, various scopes. Open Tues. and Fri. evenings.

Vincennes: Dunseth Planetarium, Vincennes Community College, 47591, (812) 885-4229, 40' dome theater (Viewlex Mercury). Open by reservation.

IOWA

Cedar Falls: Hillside Observatory, Univ. of Northern Iowa, Dept. of Earth Sciences, 50614, (319) 273-2759, observatory (16" reflector). Not open in summer. Program info. line: 273-6063.

Cherokee: Sanford Museum and Planetarium, 117 East Willow St., 51012, (712) 225-3922, 18' dome theater, exhibits. Open last Sun. of each month.

Decorah: Luther College Planetarium, Physics Dept., 700 College Dr., 52101, (319) 387-1712, 20' dome theater (Spitz AP3), tours. Open by reservation. Program info. line: 387-1117.

Des Moines: Drake Univ. Observatory, Drake Univ., 50311, (515) 271-3141, Open Fri. evenings.

Des Moines: Science Center of Iowa/Sargent Planetarium, 4500 Grand Ave., 50312, (515) 274-6868, 40' dome theater (Digistar 2), exhibits. Program info. line: 274-4138.

Dubuque: Heitkamp Memorial Planetarium, Loras College, Dept. of Physics, 52001, (319) 588-7100, 30' dome theater (Goto Venus). Open Fri. evenings. Not open in summer.

Sioux City: Briar Cliff College Planetarium, 3303 Rebecca St., 51104, 17' dome theater (Spitz A-1), exhibits. Open daily in summer except holidays. Planetarium programs by reservation only.

Waterloo: Grout Museum of History and Science, 503 South Street, 50701, (319) 234-6357, 15' dome planetarium (Spitz 373), star parties. Open Tues. - Sat.

KANSAS

Emporia: Peterson Planetarium, Emporia State Univ., 1200 Commercial, 66801, (316) 341-5980, 30' dome theater (Spitz A3P). Open by reservation. Not open in summer.

Great Bend: Barton County Community College Planetarium, Bissells Point Rd., 67530, (316) 792-2701, 30' dome theater (Spitz A4). Open by reservation.

Greensburg: Pallasite Meteorite, The Big Well, 315 South Sycamore, 67054, (316) 723-2261. Open daily.

Hutchinson: Kansas Cosmosphere and Space Center, 1100 North Plum Street, 67501, (316) 662-2305, 30' dome theater (Spitz A3P), OMNIMAX®, exhibits, tours. Open daily.

Salina: Kansas Wesleyan Univ. Observatory, 100 E. Claflin, 67401, (913) 827-5541, 16" Cassegrain. Monthly public nights. Also open by reservation.

Topeka: Washburn Univ. Planetarium, Dept. of Astronomy and Physics, 17th and College, 66621, (913) 231-1010 x1330, 20' dome theater (Viewlex Mercury), observatory (12" refractor). Open by reservation.

Wichita: Lake Afton Public Observatory, 1845 Fairmount, 67208, (316) 689-3191, observatory (16" Cassegrain). Open Fri., Sat., and Sun. evenings during summer. Program info. line: 794-8995.

Wichita: Omnisphere and Science Center, 220 South Main St., 67202, (316) 264-3174, 30' dome theater (Spitz 512), exhibits, tours. Open daily. Program info. line: 264-6178.

KENTUCKY

Berea: Weatherford Planetarium, Berea College, CPO 2326, 40404, (606) 986-9341, 30' dome theater, observatory (16" scope). Open Sat. and Sun. afternoons only.

Georgetown: Georgetown College Planetarium, 400 E. College St., 40324-1696, (502) 863-8436, 35' dome theater. Open by reservation.

Golden Pond: Golden Pond Planetarium, Tennessee Valley Authority, Land Between the Lakes, 42211, (502) 924-5602, 40' dome theater (Spitz 512). Open daily in summer.

Louisville: Museum of History and Science, 727 West Main St., 40202, (502) 561-6103, exhibits, IMAX® theater. Open daily in summer.

Louisville: Rauch Memorial Planetarium, Univ. of Louisville, Belknap Campus, 40292, (502) 588-6665, 30' dome theater (Spitz 512A). Open daily. Program info. line: 588-6664.

Richmond: Hummel Planetarium, Eastern Kentucky Univ., 40475, (606) 622-1547, 67' dome theater (Spitz Space Voyager). Open daily except between Christmas and New Year's Day.

LOUISIANA

Baton Rouge: Louisiana Arts and Science Center Planetarium, 502 North Blvd., 70821, (504) 344-9465. Open Tues. - Sun.

Kenner: Freeport McMoran Daily Living Science Center, 409 Williams Blvd., 70062, (504) 468-7229, 26' dome theater (Spitz A3P), observatory (14" SCT). Open daily except Mon. and major holidays.

Lafayette: Natural History Museum and Planetarium, 637 Girard Park Dr., 70503, (318) 268-5544, 30' dome theater (Spitz A4), exhibits, public observing. Open daily in summer.

Luling: St. Charles Parish Library Planetarium, 91 Lakewood Dr., 70070, (504) 785-8471, 20' dome theater (Viewlex Apollo), observatory (8" SCT), tours. Open Mon. - Sat. Not open on holidays.

New Orleans: Louisiana Nature and Science Planetarium, Joe W. Brown Memorial Park, P.O. Box 870610, 70187, (504) 246-5672, 30' dome theater (Spitz A4), laser shows. Open Tues. - Sun. Program info. line: 246-7827.

MAINE

Castine: Planetarium, Maine Maritime Academy, 04420, (207) 326-4311, 20' dome theater (Spitz). Open by reservation.

Easton: Francis Malcolm Science Center Planetarium, P.O. Box 186, U.S. Route 1-A, 04740, (207) 488-5451, 24' dome theater (Spitz 373), 13" Dobsonian. Open Mon. - Fri. Not open in summer.

Fairfield: North Starlab Planetarium, 4 Osborne St., 04937, (207) 453-7668, 16' dome theater (Starlab). Open by reservation.

Lewiston: Bates College Planetarium, Dept. of Physics and Astronomy, 04240, (207) 786-6320.

Orono: Univ. of Maine Planetarium, 5781 Wingate Hall, 04469-5781, (207) 581-1341, 20' dome theater (Spitz 373), observatory (8" refractor). Open by reservation.

Portland: Southworth Planetarium, Univ. of So. Maine, 96 Falmouth St., 04103, (207) 780-4249, 30' dome theater (Zeiss Jena ZKP2), exhibits. Open daily.

MARYLAND

Annapolis: McKeldin Memorial Planetarium, St. John's College, 60 College Ave., 21401, (301) 263-2371, 24' dome theater.

Annapolis: Planetarium, U.S. Naval Academy, Luce Hall Seanav, 21402, (301) 267-3952, 40' dome theater (Goto MK 12). Open by reservation.

Baltimore: K. Brice Bryan Planetarium, College of Notre Dame, 4701 N. Charles St., 21210, (410) 435-0100, 20' dome theater (Spitz Nova II), observatory (20" reflector). Open by reservation. Program info. line: 532-5702.

Baltimore: Maryland Science Center, Davis Planetarium, 601 Light St., 21230, (410) 685-2370, 50' dome theater (Minolta MS15), observatory (8" refractor), IMAX® theater, exhibits. Open daily except Thanksgiving and Christmas. Program info. line: 685-5225.

Baltimore: Space Telescope Science Institute, 3700 San Martin Dr., 21218, (301) 338-4700. Open by reservation for group tours.

College Park: Univ. of Maryland Observatory, 1205 Space Sciences Building, 20742, (301) 454-3001, observatory (7"-20" scopes), slide shows, and public observing. Open fifth and twentieth of each month in evening.

Frostburg: Frostburg State Univ. Planetarium, Tawes Hall Lobby, Frostburg State Univ., 21532, (301) 689-4298, 24' dome theater (Spitz A4). Open by reservation. Program info. line: 689-4270.

Greenbelt: NASA Goddard Space Flight Center, Visitor Center, Code 130, 20771, (301) 286-8981, tours by reservation. Open Wed. - Sun. 10 a.m. - 4 p.m.

Hagerstown: Washington County Planetarium, 823 Commonwealth Ave., 21740, (301) 791-4172, 30' dome theater (Spitz A4RPY), exhibits. Open daily for school groups and Tues. evenings for public. Not open in summer.

Takoma Park: Montgomery College Planetarium, Takoma Ave. and Fenton St., 20910-4197, (301) 650-1463, 24' dome theater (Spitz 512), observatory (3.5" and 8" scopes). Open by reservation for field trips.

Worton: Kent County High School Planetarium, 25301 Lambs Meadows Road, 21678, (410) 778-4540, 30' dome theater (Spitz A3P), observatory (6" reflector). Open daily Sept. - June. Reservations accepted July - Aug.

MASSACHUSETTS

Amherst: Bassett Planetarium and Wilder Observatory, Amherst College, Dept. of Astronomy, 01002, (413) 542-2138, 30' dome theater (Spitz A3P), observatory (18" refractor). Observatory open every clear Sat. evening; planetarium open Sept. - May Sun. 3 p.m., weekdays by reservation.

Amherst: Orchard Hill Observatory, Univ. of Massachusetts, 01002, (413) 545-0111, 20" Cassegrain. Open by reservation.

Boston: Boston Univ. Dept. of Astronomy Observatory, 725 Commonwealth Ave., College of Liberal Arts, 02215, (617) 353-5700, observatory (14" and many other scopes), monthly lectures. Open every clear Wed. night. Program info. line: 353-2630.

Boston: Charles Hayden Planetarium, Boston Museum of Science, 02114-1099, (617) 589-0270, 60' dome theater (Zeiss VI), OMNIMAX®, exhibits. Open daily except Thanksgiving and Christmas Day. Program info line: 723-2500.

Cambridge: Harvard-Smithsonian Center for Astrophysics, 60 Garden St., 02138, (617) 495-7461, observatory (9" refractor). Public observing on third Thurs.

Cambridge: Wallace Astrophysical Observatory, Massachusetts Institute of Technology, Building 54-410, 02139, (617) 253-9317, 24" scope, tours. Open by reservation.

Deerfield: Andrews Planetarium, Deerfield Academy, 01342, (413) 772-0241, 40' dome theater (Viewlex Mark IIB), observatory (10" SCT). Open by reservation.

Fall River: Durfee High Planetarium/Observatory, 360 Elsbree St., 02720, (508) 675-8170, 26' dome theater (Viewlex Apollo), observatory (8" refractor). Open once a month.

Nantucket: Maria Mitchell Association, 2 Vestal St., 02554, (508) 228-9198. Public observing Wed. evenings July and Aug. only. Program info. line: 228-9273.

Norton: Wheaton College Observatory, Dept. of Physics and Astronomy, Wheaton College, 02766, (508) 285-7722 x422, observatory (7 scopes). Open clear Thurs. evenings when college is in session.

Quabbin: Five College Radio Observatory, University of Massachusetts, Amherst, 01002, (413) 545-2194, 14-meter radio telescope. Open by restricted reservation.

Springfield: Springfield Science Museum, 236 State St., 01103, (413) 733-1194, exhibits, 33' dome planetarium, observatory (20" reflector). Open afternoons only, Thurs. - Sun.

Wenham: Woodside Planetarium and Observatory, 13 Friend Court, 01984, (508) 468-4815, 14' dome theater (Eros), observatory (14" SCT). Open by reservation.

Westford: Haystack Observatory, Route 40, 01886, (508) 692-4764, radio scope. Tours by reservation. Open house in October.

Whatley: Whatley Observatory, Univ. of Massachusetts, 01002, (413) 545-0111, 20" infrared scope. Open by restricted reservation.

Williamstown: Hopkins Observatory/Milham Planetarium, Williams College, Main St., 01267, (413) 597-2105, 16' dome theater (Spitz A3P), observatory (24" scope). Open by reservation. Program info. line: 597-2188.

Worchester: New England Science Center, 222 Harrington Way, 01604, (508) 791-9211, 40' dome planetarium (Spitz A4RPY), observatory (14" Cassegrain), exhibits. Open daily except Christmas, New Year's Day, and Easter Sunday.

MICHIGAN

Alpena: Jesse Besser Museum and Planetarium, 491 Johnson St., 49707, (517) 356-2202, 33' dome theater (Spitz A3P), exhibits, tours. Open daily.

Ann Arbor: Exhibit Museum Planetarium, 1109 Geddes Ave., 48109-1079, (313) 764-0478, 18' dome theater (Spitz A4), exhibits, tours. Open daily except major holidays.

Battle Creek: Gardner Memorial Planetarium, Kingman Museum of Natural History, West Michigan Ave. at 20th St., 49017, (616) 965-5117, 16' dome theater (Viewlex Apollo), exhibits. Open daily in summer.

Bloomfield Hills: Cranbrook Institute of Science, 1221 N. Woodward Ave., 48303, (313) 645-3235, 30' dome theater — McMath Planetarium (Spitz 512), Hulbert Observatory (6" refractor), laser shows, exhibits. Open daily. Program info. line: 645-3200.

Detroit: Children's Museum/Detroit Public Schools, 67 East Kirby, 48202, (313) 494-1210, exhibits, planetarium shows. Open daily in summer.

Detroit: Detroit Science Center, 5020 John R St., 48202, (313) 577-8430, exhibits, planetarium shows, laser shows, OMNIMAX® theater, public observing. Open Tues. - Sun.

East Lansing: Abrams Planetarium, Michigan State Univ., 48824-1324, (517) 355-4676, 50' dome theater (Digistar), public observing. Program info.line: 355-4672.

Flint: Robert T. Longway Planetarium, 1310 East Kearsley St., 48503, (313) 760-1181, 60' dome theater (Spitz B), exhibits, tours. Public shows every weekend and also open by reservation.

Grand Rapids: Roger B. Chaffee Planetarium, Grand Rapids Public Museum, 54 Jefferson SE, 49503, (616) 456-3985, 30' dome theater (Goto M1), exhibits. Open daily except major holidays. Program info. line: 456-3200.

Jackson: Michigan Space Center, 2111 Emmons Rd., 49201, (517) 787-4425, exhibits, tours, space artifacts. Open daily.

Kalamazoo: Kalamazoo Public Museum Planetarium, 315 South Rose St., 49007, (616) 345-7092, 30' dome theater (Spitz A4), exhibits. Open Tues. - Sun.

Lansing: Impression Five Science Museum, 200 Museum Dr., 48933, (517) 485-8116, interactive exhibits. Open daily.

Lowell: James C. Veen Observatory, 3308 Kissing Rock Rd. SE, 49331, (616) 456-3985, observatory (6", 12", 14", and 17" scopes), exhibits, tours. Open second Sat. and last Fri., Apr. - Oct. Program info. line: 897-7065.

Marquette: Shiras Planetarium, 1203 West Fair Ave., 49855, (906) 225-4250, 30' dome theater (Minolta MS8), exhibits. Open Mon. and Wed. only. Program info. line: 225-4204.

Mount Pleasant: Brooks Observatory, Physics Dept., Central Michigan Univ., 48859, (517) 774-3321, observatory (14" SCT). Open one Thurs. evening per month during academic year.

Muskegon: CARR-FLES Planetarium, Muskegon Community College, 221 S. Quarterline Rd., 49442, (616) 777-0289, 24' dome theater (Spitz A3P). Open Mon. - Fri. by reservation only. Not open in summer.

Ypsilanti: Sherzer Observatory, Physics and Astronomy Dept., 303 Strong Hall, Eastern Michigan Univ., 48197, (313) 487-4144, observatory (10" refractor), exhibits, tours. Open by reservation. Program info. line: 487-3033.

MINNESOTA

Duluth: Alworth Planetarium, 10 Univ. Dr., Univ. of Minnesota-Duluth, 55812, (218) 726-7129, 32' dome theater (Spitz A3P), exhibits. Open daily. Free public shows Wed. 7:00 p.m. Group shows by reservation.

Hibbing: Paulucci Space Theater, Arrowhead Community College Region, Hwy 169 and East 23rd St., 55746, (218) 262-6718, 40' dome theater (Spitz 512), Cinema 360°. Open daily in summer. Program info. line: 262-6720.

Marshall: Southwest State Univ. Planetarium, 56258, (507) 537-6196, 30' dome theater (Spitz 512). Open by reservation. Not open in summer.

Minneapolis: Minneapolis Planetarium, 300 Nicollet Mall, 55401, (612) 372-6543, 40' dome theater (Spitz C), exhibits, laser shows. Open daily except some holidays. Program info. line: 372-6644.

Moorhead: Moorhead State Univ. Planetarium, 8th Ave. and 11th St. S, Bridges Hall 167, 56563, (218) 236-2904, 30' dome theater (Spitz 512A). Open Thurs. evenings during summer. Program info. line: 236-3982.

New Ulm: Dr. Martin Luther College, 1884 College Heights, 56073, (507) 354-8221, 12' dome theater, observatory (17" scope). Open by reservation.

St. Cloud: SCSU Observatory and Planetarium, St. Cloud State Univ., MS 324, 56301, (612) 255-2011, 30' dome theater (Spitz 512), observatory (5", 8", 10", and 11" scopes). Open by reservation.

St. Paul: Macalester College Planetarium, 1600 Grand Ave., 55105, (612) 696-6000, 22' dome theater, observatory (25" scope). Not open to public.

St. Paul: Science Museum of Minnesota/McKnight Omni-theater, 30 E. 10th St., 55101, (612) 291-9403, exhibits, OMNIMAX® theater. Open daily.

MISSISSIPPI

Bay St. Louis: NASA John C. Stennis Space Center, Stennis Space Center, 39529, (601) 688-2370, visitor center, exhibits, tours. Open daily 9 a.m. - 5 p.m.

French Camp: Rainwater Observatory and Planetarium, French Camp Academy, 39745, (601) 547-6865, 20' dome theater (Observadome), observatory (30" reflector and other scopes). Open by reservation.

Goodman: Holmes Community College Observatory, Dept. of Science and Mathematics, Holmes Community College, 39079, 10' dome theater (Goto Ex3), observatory (14" SCT). Open by reservation. Program info. line: (601) 472-2312 x64.

Jackson: Russell Davis Planetarium, 201 East Pascagoula St., 39205, (601) 960-1550, 60' dome theater (Minolta IV), laser shows, Cinema 360°, exhibits. Open daily except holidays. Program info. line: 960-1540.

Oxford: Kennon Observatory, Univ. of Mississippi, Dept. of Physics and Astronomy, 38677, (601) 232-7046, 15" refractor. Open by reservation.

MISSOURI

Columbia: Laws Observatory, Dept. of Physics and Astronomy, Univ. of Missouri, 65211, (314) 882-3335, observatory (16" scope). Open Fri. evenings in summer.

Kansas City: Kansas City Museum Planetarium, 3218 Gladstone Blvd., 64123, (816) 483-8300, 20' dome theater (Apollo Viewlex), exhibits. Open daily in summer. Program info. line: 483-STAR.

St. Louis: St. Louis Science Center, 5050 Oakland Ave., 63110, (314) 289-4400, 60' dome planetarium (Digistar), OMNIMAX®, exhibits. Open daily except Thanksgiving, Christmas, and New Year's Day. Program info. line: 289-4444.

MONTANA

Bozeman: Taylor Planetarium, Museum of the Rockies, Montana State Univ., 59717, (406) 994-2251, 40' dome theater (Digistar), public observing. Open daily in summer.

NEBRASKA

Chadron: Chadron State College Planetarium, 10th and Main St., 69337, (308) 432-6219, 25' dome theater (Spitz AP3). Open by reservation.

Fremont: Lueninghoener Planetarium, Midland Lutheran College, 900 N. Clarkson, 68025, (402) 721-6328, 30' dome theater (Spitz A3P), observatory (11" SCT). Open by reservation.

Hastings: J. M. McDonald Planetarium, 1330 North Burlington Ave., 68901, (402) 461-2399, 24' dome theater (Minolta MS8), observatory (14" SCT), exhibits. Planetarium open daily except major holidays; observatory open by reservation only. Program info. line: 461-2395.

Kearney: Bruner Hall of Science Planetarium, University of Nebraska at Kearney, 68849, (308) 234-8277, 24' dome theater (Spitz A3P), observatory (16" scope). Open by reservation. Program info. line: 234-8675.

Lincoln: Behlen Observatory, Dept. of Physics and Astronomy, Univ. of Nebraska, 68505, (402) 472-2770, observatory (30" Cassegrain). Open once in spring and fall and by reservation.

Lincoln: Hyde Memorial Observatory, South Shore Rd. Holmes Park, 68506, (402) 471-7960, observatory (14" SCT). Open Sat. evenings and by group reservation. Program info. line: 471-7094.

Lincoln: Jensen Planetarium, Nebraska Wesleyan Univ., 5000 Saint Paul Ave., 68504-2796, (402) 465-2246, observatory for educational purposes only. Not open to public.

Lincoln: Mueller Planetarium, Univ. of Nebraska State Museum, 213 Morrill Hall, 68588-0338, (402) 472-2641, 34' dome theater (Spitz A4RP4), laser shows. Open Tues. - Sun.

Omaha: Durham Science Center and Kountze Planetarium, Univ. of Nebraska at Omaha, 68th and Dodge St., 68182, (402) 554-3727, 33' dome theater, laser shows, observatory. Open Fri. - Sun. only.

Wayne: Fred G. Dale Planetarium, Wayne State College, Box 77 W.S.C., 68787, (402) 375-7343, 30' dome theater (Spitz A4). Open by reservation.

NEVADA

Las Vegas: Community College of Southern Nevada Planetarium, 3200 E. Cheyenne Ave., 89030, (702) 643-6060 x335, 30' dome theater (Spitz 512), observatory (8" SCT), Cinema 360°, tours. Open Fri. and Sat. year round. Program info. line: 644-5059.

Reno: Fleischmann Planetarium, Univ. of Nevada-Reno, Mail Stop 272, 1650 N. Virginia St., 89557, (702) 784-4812, 30' dome theater (Minolta II), observatory (12" reflector), Cinema 360°. Open daily.

NEW HAMPSHIRE

Concord: Christa McAuliffe Planetarium, 3 Institute Dr., 03301, (603) 271-7831, 40' dome theater (Digistar), 13" reflector, exhibits. Open Tues. - Sun. Program info. line: 271-STAR.

Durham: Univ. of New Hampshire Observatory, DeMeritt Hall, 03824, (603) 862-1950, observatory (14" Cassegrain). Open twice monthly year round.

Plymouth: Plymouth State College Planetarium, Boyd Hall, 03264, (603) 535-2748, 20' dome theater (Nova II). Open monthly for public shows and by reservation. Program info. line: 535-2325.

NEW JERSEY

Allendale: Northern Highlands Planetarium, Hillside Ave., 07401, (201) 934-1087, 25' dome theater (Spitz 512), exhibits. Open daily with seasonal schedules.

Mountainside: Trailside Nature and Science Center, Coles Ave. and New Providence Rd., 07092, (908) 789-3670, 18' dome theater (Nova III). Open daily.

Newark: Dreyfuss Planetarium, 49 Washington St., 07101, (201) 596-6609, 24' dome theater (Minolta MS8). Open daily in summer and weekends year round. Program info. line: 596-6611.

Randolph: County College of Morris Planetarium, 214 Center Grove Rd., 07869, (201) 328-5755, 33' dome theater (Viewlex IIB), observatory (7" Maksutov), exhibits. Open daily except holidays.

Toms River: Robert J. Novins Planetarium, Ocean County College, 08754-2001, (908) 255-0343, 40' dome theater (Minolta IIB). Open daily except Sat. and Sun. during July and Aug. Program info. line: 255-0342.

Trenton: New Jersey State Museum Planetarium, 205 West State St., CN 530, 08625-0530, (609) 292-6333, 40' dome theater (Minolta MS10), exhibits. Open daily except Mon.

NEW MEXICO

Alamogordo: Clyde W. Tombaugh Space Theater, P.O. Box 533, 88310, (505) 437-2840, 40' dome theater (Spitz 512), OMNIMAX®, laser shows, exhibits. Open daily except Christmas. Program info. line: (800) 545-4021.

Albuquerque: Univ. of New Mexico Observatory, Institute for Astrophysics, 800 Yale Blvd. NE, 87131, (505) 277-2616, observatory (12" SCT and 8" scopes). Open Fri. evenings during academic year.

Farmington: San Juan College Planetarium, San Juan College, 4601 College Blvd., 87402, (505) 599-0361, 24' dome theater (Spitz 373). Not open in summer.

Roswell: Robert H. Goddard Planetarium, Roswell Museum and Art Center, 11th and North Main, 88201, (505) 624-6744, 40' dome theater (Spitz A3), exhibits, tours, public observing. Open daily in summer and one week per month during school year.

Santa Fe: Santa Fe Children's Observatory, Route 19, Box 90-DJ, 87505, (505) 983-4011, observatory (16" SCT). Scheduled to open in Aug. Open daily by appointment.

Sapello: Star Hill Inn, 87745, (505) 425-5605, 14" SCT and many other scopes available to guests of Inn.

Retreat for amateur astronomers. Open daily.

Socorro: Very Large Array, National Radio Astronomy Observatory, P.O. Box O, 87801-0387, (505) 835-7000, 27-element array of 85' dishes, exhibits, self-guided tours. Open daily.

Sunspot: Apache Point Observatory, P.O. Box 59, 88349, (505) 437-6822. Open by reservation.

Sunspot: ARC telescope, N. M. State Univ., Dept. of Astronomy, Box 30001, Dept. 4500, Las Cruces, 88003, (505) 646-4438. ARC Telescope open daily in summer.

Sunspot: National Solar Observatory, Sacramento Peak, 88349, (505) 434-7000, 64" telescope, guided tours every Sat. at 2 p.m. Open daily, daytime only.

NEW YORK

Alfred: Observatory, Alfred Univ., 14802, (607) 871-2208, 20" and 32" scopes. Open weekly Feb. - July and Sept. - Nov.

Binghamton: Roberson Center for the Arts and Sciences/Link Planetarium, 30 Front St., 13905, (607) 772-0660, 30' dome theater (Spitz A3P), observatory (14" scope), laser shows, exhibits, tours, star parties. Planetarium open Tues. - Sun.

Bronx: Northeast Bronx Planetarium, 750 Baychester Ave., 10475, (718) 904-5520, 40' dome theater (Spitz A4 RPY), observatory (8" reflector and 4" refractor). Open by reservation. Not open in summer.

Brooklyn: Edwin P. Hubble Planetarium, 1600 Ave. L, 11230, (718) 258-9283, 24' dome theater (Goto Mercury S1). Open Mon. - Fri. by reservation only. Not open in summer.

Buffalo: Whitworth/Ferguson Planetarium, Buffalo State College, 1300 Elmwood Ave., 14222-1095, (716) 878-4911, 24' dome theater (Spitz 512), video theater, exhibits. Open daily by reservation.

Centerport: Vanderbilt Planetarium, 180 Little Neck Rd., 11721, (516) 262-7800, 60' dome theater (Goto), observatory (16" Cassegrain), exhibits, tours, laser shows. Open Tues. - Sun. Program info. line: 262-STAR.

Geneseo: SUNY-Geneseo Telescope Facility, Dept. of Physics-Astronomy, SUNY, 209 Greene Science Building, 14454, (716) 245-5282, observatory (14" SCT). Open by reservation. Not open in summer.

Herkimer: Herkimer County BOCES Planetarium, 400 Gros Blvd., 13350, (315) 867-2000, 33' dome theater (Minolta MS8), 8" reflector. Open by reservation.

Ithaca: Cornell Univ. Observatory, Dept. of Astronomy, Space Sciences Bldg., 14853, (607) 255-4935, 14" and 12" scopes. Public observing Fri. evenings.

Middle Island: Longwood Regional Planetarium, 41 Yaphank Middle Island Rd., 11953, (516) 345-2741, 30' dome theater (Goto Venus). Open by reservation.

New Paltz: John R. Kirk Planetarium, State Univ. College, CSB 28, 12561, (914) 257-3818, 24' dome theater, observatory (8" scope). Open by reservation. Not open in summer.

New York: American Museum/Hayden Planetarium, Central Park West at 81st St., 10024-5192, (212) 769-5900, 75' dome theater (Zeiss VI), exhibits, lectures, concerts, children's program, courses. Open daily except Christmas.

New York: City College of New York Planetarium, Science and Physics Building, 138th St. and Convent Ave., 10031, (212) 650-6832, 30' dome theater (Spitz 512). Open by reservation.

New York: New York Hall of Science, 47-01 111th St., 11368, (718) 699-0005, shows, exhibits. Open Wed. - Thurs. for groups only.

North Massapequa: Plainedge Planetarium, Packard Middle School, N. Idaho Ave., 11758, (516) 755-5723, 24' dome theater (Spitz A3P), observatory (8" Cassegrain). Open in summer by reservation.

Poplar Ridge: Southern Cayuga Planetarium, Route 34B, 13139, (315) 364-7111, 30' dome theater (Spitz A4), public observing (various scopes), exhibits. Open Sept. - June by reservation only.

Potsdam: Potsdam College Planetarium, Pierrepont Ave., 13676, (315) 267-2284, 24' dome theater (Spitz A3P). Open by reservation. Program info. line: 267-2286.

Rochester: C.E.K. Mees Observatory, Univ. of Rochester, Dept. of Physics and Astronomy, 14627, (716) 275-0539, observatory (24" Cassegrain), tours. Open by reservation.

Rochester: Strasenburgh Planetarium, Rochester Museum and Science Center, 657 East Ave., 14603-1480, (716) 271-4320, 65' dome theater (Zeiss Mark VI), exhibits, observatory (12.5" reflector). Open daily. Program info. line: 442-7171.

Schenectady: Schenectady Museum and Planetarium, Nott Terrace Heights, 12308, (518) 382-7890, 30' dome theater (Spitz A3PR), laser shows, exhibits, tours. Open Tues. - Sun.

Staten Island: Wagner College Planetarium, 631 Howard Ave., Grymes Hill, 10301, (718) 390-3432, 30' dome theater (Spitz A3P). Open Mon. - Fri.

Syracuse: Museum of Science and Technology, 500 South Franklin St., 13202, (315) 425-9068, 24' dome theater (Apollo Viewlex), exhibits, public observing. Open daily except Thanksgiving and Christmas. Program info. line: 425-0747.

Troy: The Junior Museum, 282 5th Ave., 12182, (518) 235-2120, 12' dome theater (custom-made), exhibits, tours, displays. Open daily in summer.

Yonkers: Andrus Planetarium, Hudson River Museum, 511 Warburton Ave., 10701, (914) 963-4550, 40' dome theater (Zeiss M1015), exhibits. Open Wed. - Sun.

NORTH CAROLINA

Chapel Hill: Morehead Planetarium, CB# 3480, E. Franklin St., Univ. of North Carolina, 27599-3480, (919) 962-1236, 68' dome theater (Zeiss VI), observatory (24" Cassegrain), Cinema 360°, exhibits. Open daily in summer. Program info. line: 549-6863.

Charlotte: Discovery Place/Nature Museum, 301 North Tryon St., 28202, (704) 372-6261, planetarium, OMNIMAX® theater.

Durham: North Carolina Museum of Life and Science, 433 Murray Ave., 27704, (919) 220-5429, exhibits, space artifacts. Open daily in summer.

Gastonia: Schiele Museum of Natural History and Planetarium, 1500 East Garrison Blvd., 28052, (704) 866-6922, 50' dome theater (Spitz 512), Cinema 360°, exhibits. Open daily except Mon. Program info. line: 866-6900.

Greensboro: Edward Zane Planetarium, Natural Science Center, 4301 Lawndale Dr., 27408, (919) 288-3769, 40' dome theater (Spitz 512), exhibits, solar observatory. Open daily in summer.

Greensboro: Three College Observatory, Dept. of Physics and Astronomy, Univ. of North Carolina-Greensboro, 27412, (919) 334-5669, observatory (32" Cassegrain). Open by reservation.

Hickory: Catawba Science Center, 243 3rd Ave. NE, P.O. Box 2431, 28603, (701) 322-8169, exhibits, Starlab planetarium. Open Tues. - Sun.

Hudson: Caldwell Community College Planetarium, 1000 Hickory Blvd., 28638, (704) 726-2200, 20' dome theater. Open by reservation.

Lumberton: Robeson Science and Technology Center, Hwys. 72 and 711, P.O. Drawer 2909, 28359, (919) 671-6015, 30' dome theater (Spitz A3PR), observatory (6" reflector), shows, exhibits. Open daily in summer except July.

Rocky Mount: Rocky Mount Planetarium, Children's Museum, 1610 Gay St., 27804, (919) 972-1167. Planetarium open by reservation only.

Salisbury: Margaret C. Woodson Planetarium, 1636 Parkview Circle, 28144, (704) 636-3462, exhibits, observatory. Open Mon. - Fri. and by reservation on Sat. and Sun. evenings.

Winston-Salem: Hanes Planetarium, Nature Science Center, 1 Museum Dr., 27104, (919) 767-6730, 50' dome theater (Spitz 512), exhibits, observatory. Open daily in summer. New planetarium opening this fall.

NORTH DAKOTA

Grand Forks: Arthur P. Anderson Atmospherium, Univ. of North Dakota, P.O. Box 8216, University Station, 58202, (701) 777-2791, 40' dome planetarium (Digistar). Open daily in summer.

Minot: Minot State Univ. Observatory, 500 University Ave. West, 58707, (701) 857-3071, observatory (16" SCT). Not open in summer.

Valley City: Valley City State Univ. Planetarium, Valley City State Univ., 58072, (701) 845-7334, 24' dome theater (Spitz 512A). Open by reservation.

OHIO

Canton: Hoover-Price Planetarium, McKinley Museum, 800 McKinley Monument Dr., 44701, (216) 455-7043, 25' dome theater (Spitz A3P), science center, park, exhibits, tours. Open daily except major holidays.

Cincinnati: Cincinnati Museum of Natural History and Planetarium, 1720 Gilbert Ave., 45202, (513) 345-8500, 32' dome theater (Minolta Series II). Open daily in summer. Program info. line: 345-8505.

Cincinnati: Cincinnati Observatory, 3489 Observatory Place, 45208, (513) 321-5186, observatory (16" and 11" refractors). Open by reservation.

Cleveland: Cleveland Museum of Natural History, 1 Wade Oval Dr., University Circle, 44106, (216) 231-4600, Mueller Planetarium (30' dome, Spitz A3P), observatory (10.5" refractor) exhibits. Open daily except some holidays.

Cleveland: NASA Lewis Visitor Center, 21000 Brookpark Rd. MS 8-1, 44135, (216) 433-2001, exhibits, tours. Open daily except major holidays.

Cleveland: Warner and Swasey Observatory, Case Western Reserve Univ., 44106, (216) 368-3728.

Columbus: Center of Science and Industry, Batelle Planetarium, 280 East Broad St., 43215, (614) 228-2674 x209, 30' dome theater (Spitz A3P), exhibits. Open daily except major holidays.

Columbus: Ohio State Univ. Planetarium, 174 West 18th Ave., 43210, (614) 292-1773, 26' dome theater. Open first Wed. of each month Oct. - Aug.

Dayton: Dayton Museum of Natural History, 2600 DeWeese Parkway, 45414, (513) 275-7431, 50' dome theater (Digistar), observatory (20" SCT), exhibits. Open daily except Mon.

Delaware: Perkins Observatory, P.O. Box 449, 43015, (614) 363-1257, 32" reflector. Located on Route 23, 3 miles south of Delaware. Open Mon. - Fri. afternoons only. Public observing one evening per month, June - Oct.

Findlay: Newhard Planetarium, Findlay College, 1000 N. Main St., 45840, (419) 424-4533, 24' dome theater (Goto S-3).

Granville: Swasey Observatory, Denison Univ., 43023, (614) 587-6311, observatory (9" scope). Open evenings by reservation only.

Kent: Kent State University Planetarium, Physics Department, 44242, (216) 672-2771, 40' dome theater (Spitz A3P), observatory (12" reflector). Open by reservation. Four series (3 shows each) of public shows annually.

Sylvania: Copernicus Planetarium, Lourdes College, 6832 Convent Blvd., 43560-2898, (419) 885-3211, 24' dome theater (Spitz A3P), observatory (8" reflector). Not open in summer. Program info. line: 885-3211 x251.

Toledo: Ritter Planetarium and Brooks Observatory, Univ. of Toledo, 2801 W. Bancroft St., 43606, (419) 537-4641, 40' dome theater (Spitz A3P), observatory (1-meter reflector), heliostat, exhibits, tours. Open Fri., Sat., and Sun.; open Mon. - Thurs. by reservation. Program info. line: 537-4037.

Wapakoneta: Neil Armstrong Air and Space Museum, 1500 Bellefontaine Street, 45895, (419) 738-8811, 60' dome theater, exhibits, tours. Open March - Nov.

Westerville: North American Astrophysical Observatory, Otterbein College, 43081, (614) 898-1516, 320' by 71' radio telescope. Open by reservation.

Wilmot: Wilderness Center Planetarium, 9877 Alabama Ave. SW, P.O. Box 202, 44689-0202, (216) 359-5235, 12' dome theater (Techline). Open daily in summer.

Youngstown: Ward Beecher Planetarium, Youngstown State Univ., 44555-0001, (216) 742-3136, 40' dome theater, laser shows, observatory (14" scope). Open by reservation.

OKLAHOMA

Fort Sill: Fort Sill Planetarium, Target Acquisition Dept., 73503, (405) 351-6616. Only planetarium on an army base. Open by reservation.

Oklahoma City: Kirkpatrick Planetarium, OMNIPLEX Science Museum, 2100 N.E. 52nd, 73111, (405) 424-5545, 40' dome theater (Minolta MS10), observatory (8" and 16" scopes). Open daily.

OREGON

Bend: Pine Mountain Observatory, Univ. of Oregon, Bend-Burns Star Route, 97702, (503) 382-8331, 32" and 24" scopes. Open by reservation.

Eugene: Lane ESD Planetarium, 2300 Leo Harris Parkway, 97401, (503) 689-6500 x227, 40' dome theater (Viewlex Minolta IIB), observatory (16" Cassegrain), exhibits. Open Thurs. - Sun. Program info. line: 687-STAR.

Eugene: Pine Mountain Observatory, Univ. of Oregon, P.O. Box 5795, 97405, 24" and 15" Cassegrains, 32" w/CCd at prime focus. Open by reservation.

Gresham: Mt. Hood Community College Planetarium, 26000 S.E. Stark St., 97030, (503) 667-7297, 30' dome theater (Spitz A4RPY), solar observatory (6" scope). Open first Sat. of each month and Tues., Wed., and Thurs. Oct. - June.

Oregon City: Haggart Observatory, c/o John Inskeep Environmental Learning Center, P.O. Box 5162, 97045, (503) 657-8400, observatory (various scopes), exhibits, tours. Public nights every clear Wed., Fri., and Sat. Located at Clackamas Community College.

Portland: Oregon Museum of Science and Technology, Kendall Planetarium, 4015 SW Canyon Rd., 97221, (503) 274-4553, 40' dome theater (Goto), exhibits. Open daily in summer. Program info. line: 228-STAR.

Portland: Oregon Museum of Science and Industry, Murdock Sky Theater, 1945 SE Water Avenue, 97214, (503) 797-4000, 52' dome theater (Goto M1), OMNIMAX®, exhibits, tours. Open daily except Christmas. Program info. line: 797-4610.

Salem: Chemeketa Community College Planetarium, 4000 Lancaster Dr. NE, P.O. Box 14007, 97309, 35' dome theater (Spitz 512). Open Fri. 7:30 p.m. and Sat. 2:00 p.m. Not open in summer. Program info. line: 399-5161.

Sunriver: Sunriver Nature Center Observatory, P.O. Box 3533, 97707, (503) 593-4442, observatory (12.5" reflector), exhibits. Open May 1 - Oct. 30; open during Thanksgiving, Christmas, spring break, and Presidents' Day.

PENNSYLVANIA

Allentown: Joseph Grady Planetarium, 620 East Rock Rd., 18103, (215) 797-3476, 21' dome theater (Spitz A3P), observatory (12.5" Cassegrain), tours, star parties. Open spring and fall by reservation. Program info. line: 967-1991

Altoona: Neil Armstrong Planetarium, 1415 6th Avenue, 16602, (814) 946-8315, 30' dome theater (Spitz 512). Open throughout academic year.

Clarion: Pierce Planetarium, Clarion Univ., 335 Pierce Science, 16214, (814) 226-1881, 40' dome theater (Spitz A3P). Not open in summer.

Edinboro: Observatory and Planetarium, Edinboro Univ., 16444, (814) 732-2469, observatory (16" SCT). Open daily in summer by reservation only.

Harrisburg: State Museum of Pennsylvania Planetarium, 3rd and North streets, Box 1026, 17108-1026, (717) 783-9914, 30' dome theater (Spitz A3P), exhibits. Open daily in summer except Mon.

Lancaster: North Museum Planetarium, Franklin and Marshall College, P.O. Box 3003, 17604-3003, (717) 291-3941, 40' dome theater, observatory (11" refractor and 16" reflector), exhibits. Open Wed. - Sun. only. Program info. line: 291-4315.

Latrobe: Observatory, St. Vincent College, 15650, (412) 539-9761, public observing Sun. nights only by reservation.

Lewisburg: Bucknell Univ. Observatory, Dept. of Physics, 17837, (717) 524-1207, 10" Clark refractor. Open by reservation.

Lock Haven: Ulmer Planetarium, Lock Haven Univ., 17745, (717) 893-2075, 30' dome theater (Spitz A4 RPY). Open by reservation.

New Wilmington: Westminster College Planetarium, Hoyt Science Center, 16172, (412) 946-7200, 24' dome theater (Spitz 512). Open by reservation.

Philadelphia: Franklin Institute, 20th and the Parkway, 19103, (215) 448-1157, Fels Planetarium (65' dome), Tuttleman Omniverse Theater (76' dome), observatory (24" reflector and 10" refractor). Open daily. Program info. line: 448-1200.

Philadelphia: Univ. of Pennsylvania Observatory, Astronomy Dept., David Rittenhouse Laboratory, 33rd and Walnut St., 19104, (215) 898-8176. Open Mon. and Thurs. evenings only.

Pittsburgh: Allegheny Observatory, P.O. Box 7658, Observatory Station, 15214, (412) 321-2400, observatory (30" and 13" refractors, and 30" reflector), tours. Open April - October by reservation only.

Pittsburgh: Henry Buhl, Jr., Planetarium, Carnegie Science Center, One Allegheny Ave., 15212-5850, (412) 237-3397, 50' dome interactive theater (Digistar), observatory (16" automated reflector with CCD camera), OMNIMAX® theater, exhibits. Program info. line: 237-3400.

Reading: Reading School District Planetarium, 1211 Parkside Dr. South, 19611-1441, (215) 371-5854, 40' dome theater (Spitz A4), exhibits. Open Mon. - Fri., public shows at 1:00 p.m. only.

Scranton: Everhart Museum Planetarium, Nay Aug Park, 18510, (717) 346-8370. Open Tues. - Fri. by reservation.

Shippensburg: Roy Diebert Planetarium, Shippensburg Univ., 17257, (717) 532-1491, 30' dome theater (Spitz AP4). Not open in summer.

Villanova: Univ. Observatory, Mendel Hall, Villanova Univ., 19085, (215) 645-4820, 14" scope. Open by reservation.

West Chester: West Chester State Univ. Planetarium, Dept. of Geology and Astronomy, Rosedale and South Church St., 19383, (215) 436-2721, 33' dome planetarium, observatory (12" scope). Open by reservation.

Williamsport: Detwiler Planetarium, Lycoming College, 17701, (717) 321-4284, 30' dome theater (Spitz A3P). Open Sept. - May by reservation only.

PUERTO RICO

Arecibo: Arecibo Radio Observatory, 00612, (809) 878-2612.

RHODE ISLAND

Charlestown: Frosty Drew Observatory, Ninigret Park, P.O. Box 160, 02813, (401) 364-9508, observatory (7" refractor and 12.5" reflector). Open Fri. evenings if clear.

Middletown: Middletown Planetarium, Gaudet School, Aquidneck Ave., 02840, (401) 846-6395, 30' dome theater (Spitz A4), public observing. Open by reservation.

Providence: Cormack Planetarium, Museum of Natural History, Roger Williams Park, 02907-3600, (401) 785-9450, 24' dome theater (Spitz A1), observatory (6" reflector), exhibits, tours. Open Sat. and Sun. 1:00 and 3:00 p.m., June - Aug. (Tues. and Thurs. 1:00 and 3:00 p.m.), and Oct. - May (Tues. 3:30 p.m). Program info. line: 785-9457.

Providence: Ladd Observatory, 210 Doyle Ave., 02906, (401) 863-2314, 12" Brashear refractor. Public observing Wed. evenings.

Warwick: Observatory, Community College of Rhode Island, 400 East Ave., 02886, (401) 728-4171, 14" scope. Not open in summer.

SOUTH CAROLINA

Columbia: Gibbes Planetarium, 1112 Bull St., 29210, (803) 799-2810, 26' dome theater (Minolta MS10), exhibits. Open daily. Program info. line: 254-STAR.

Columbia: Melton Memorial Observatory, Univ. of South Carolina, Dept. of Physics and Astronomy, 29208, (803) 777-6466, observatory (16" Cassegrain). Open Mon. nights by reservation. Program info. line: 777-4180.

Florence: Florence Air and Space Museum, U. S. Highway 301, North Airport Entrance Rd., 29503, (803) 665-5118.

Florence: Planetarium and Observatory, Francis Marion College, P.O. Box 100547, 29501-0547, (803) 661-1250, 33' dome theater (Spitz 512), observatory (14" SCT). Open second and fourth Sun. only.

Greenville: Roper Mountain Science Center and Charles Daniel Observatory, 504 Roper Mountain Rd., 29615, (803) 281-1188, 50' dome planetarium (Digistar), observatory (23" Clark refractor). Open at 7:30 p.m. on Fri.

Orangeburg: Stanback Museum and Planetarium, P.O. Box 7636, 29117, (803) 536-8711, 40' dome theater (Minolta IIB), exhibits. Not open in summer.

Rock Hill: Settlemyre Planetarium, Museum of York County, 4621 Mt. Gallant Rd., 29730, (803) 329-2121, 30' dome theater, exhibits, public observing. Open daily in summer.

TENNESSEE

Brentwood: A. J. Dyer Observatory, 1000 Oman Dr., Vanderbilt Univ., 37027, (615) 373-4897, observatory (12" and 24" reflectors). Open eight evenings March - November.

Chattanooga: Clarence T. Jones Observatory, Univ. of Tennessee at Chattanooga, Dept. of Physics and Astronomy, 37403, (615) 755-4546, 24.5' dome planetarium, observatory (20.5" reflector). Open Fri. evenings.

Kingsport: Bays Mountain Planetarium and Nature Center, 853 Bays Mountain Park Rd., 37660, (615) 229-9447, 40' dome theater (Spitz/Goto), observatory (8" refractor), exhibits, solar observing every Sun. afternoon. Open daily in summer.

Knoxville: East Tennessee Discovery Center/Akima Planetarium, P.O. Box 6204, 516 Beaman St., 37914-0204, (615) 637-1121, 30' dome theater, exhibits. Open daily in summer, daytime only.

Memphis: Memphis Pink Palace Museum and Planetarium, 3050 Central Ave., 38111, (901) 320-6364, 50' dome theater (Minolta IV), observatory (20" reflector), exhibits, workshops. Open daily. Program info. line: 320-6320.

Nashville: Campus Observatory, Vanderbilt Univ., P.O. Box 1803, Station B, 37235, (615) 373-4897, observatory (6" refractor). Open 13-15 times per year.

Nashville: Sudekum Planetarium, Cumberland Science Museum, 800 Ridley Blvd., 37203, (615) 862-5160 x13, 40' dome planetarium (Spitz 512), exhibits. Open daily in summer.

Sewanee: Campus Observatory, Univ. of the South, 37375-1000, (615) 598-1458, observatory (11" SCT), tours. Open Thurs. 8-10 p.m. and for special events.

TEXAS

Amarillo: Don Harrington Discovery Center, 1200 Streit Dr., 79106, (806) 355-9548 x13, 40' dome theater (Spitz 512A), heliostat, Cinema 360°, exhibits. Open daily except Thanksgiving, Christmas, and New Year's Day. Program info. line: 355-9548 x4.

Dallas: Richland College Planetarium, Sarini Hall, Rm S-116, 12800 Abrams Rd., 75243, (214) 238-6005, 40' dome theater (Spitz 512), observatory (8" refractor and many more scopes), laser shows. Open daily. Program info. line: 238-6013.

Dallas: St. Mark's School of Texas Planetarium, 10600 Preston Rd., 75230, (214) 363-6491, 30' dome theater (Spitz A3P), observatory (16" Maksutov). Open by reservation.

Dallas: The Science Place Planetarium, P.O. Box 151469, 75315-1469, (214) 428-8351, 24' dome theater, exhibits. Open daily in summer.

El Paso: El Paso Planetarium, 6531 Boeing Dr., 79925, (915) 779-4316, 40' dome theater (Spitz 512A), exhibits. Open Mon. - Fri. Program info. line: 774-4317.

El Paso: Insights, El Paso Science Center, 303 N. Oregon St., 79901, (915) 542-2990.

Ft. Davis: McDonald Observatory, W. L. Moody Visitors' Center, P.O. Box 1337, 79734, (915) 426-3640, 107", 82", 36", and 30" scopes. Open daily in summer. Public observing Tues., Fri., and Sat. evenings. Viewing through 107" on Wed. near Full Moon.

Ft. Worth: Noble Planetarium, 1501 Montgomery St., 76107, (817) 732-1631, 30' dome planetarium (Spitz A3P). Open daily in summer.

Houston: Burke Baker Planetarium, Houston Museum of Natural Science, One Hermann Circle Dr., 77030, (713) 639-4632, 50' dome theater (Digistar), laser shows, IMAX® theater, George Observatory (36" scope) and Brown Observatory (16" scope). Open daily in summer. Program info. line: 639-4600.

Houston: Space Center Houston, P.O. Box 580653, 77258-0653, exhibits, tours, interactive displays. Open daily except Christmas.

Killeen: Central Texas College Planetarium, P.O. Box 1800, Hwy 190 West, 76540, (817) 526-1288, 24' dome theater (Spitz A3P), observatory (8" scope), tours. Open by reservation.

Lake Jackson: Brazosport Nature Center Planetarium, 400 College Dr., 77566, (409) 265-3376, 30' dome theater (Spitz A4), exhibits. Not open in summer.

Lubbock: Moody Planetarium, Museum of Texas Tech. Univ., 4th and Indiana Ave., 79409, (806) 742-2432, 30' dome theater (Spitz A5). Open daily.

Midland: Marian Blakemore Planetarium, Museum of the Southwest, 1705 W. Missouri, 79701-6516, (915) 683-2882, 40' dome theater (Minolta Viewlex IV), tours. Open Fri. 7:00 and 8:30 p.m.

Nacagdoches: Stephen Austin State Univ. Planetarium, Physics and Astronomy Dept., P.O. Box 13044, 75962, (409) 568-3001, 30' dome theater (Spitz 512). Open by reservation.

Odessa: Odessa Meteor Crater, 620 N. Grant, Suite 1204, 79761, (915) 332-1666,walk through crater, 8 miles southwest of Odessa on US 80. Open daily.

San Angelo: Angelo State Univ. Planetarium, Angelo State Univ., 76909, (915) 942-2136, 50' dome theater (Spitz 512A), 8" SCT, exhibits. Open Sat. and Sun., shows on Thurs. and Sat. Program info. line: 942-2188.

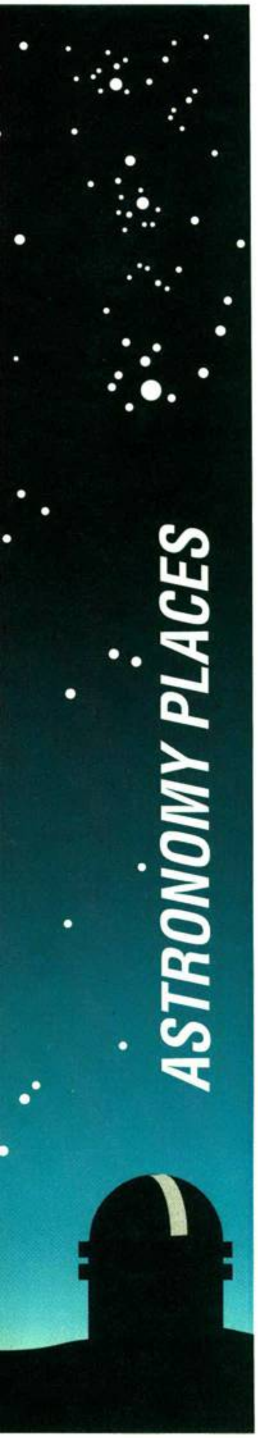
San Antonio: San Antonio College Planetarium, 1300 San Pedro Ave., 78212, (210) 733-2910, 30' dome theater (Minolta II6), observatory (14" SCT). Not open in summer. Program info. line: 733-2911.

Tyler: Hudnall Planetarium, Tyler Junior College, P.O. Box 9020, 75711, (903) 510-2578, 30' dome theater (Spitz A3P), exhibits, tours. Open Sun. - Thurs. Not open in summer. Program info line: 510-2312.

Wichita Falls: Wichita Falls Museum and Art Center Planetarium, 2 Eureka Circle, 76308, (817) 692-0923, 26' dome theater (Spitz A3P). Open Sat. and Sun. only.

UTAH

Ogden: Layton Ott Planetarium, Weber State Univ., 84408-2508, (801) 626-7907, 30' dome theater (Spitz



A4). Open Wed. evenings. Not open in summer. Program info. line: 626-6855.

Provo: Sarah Summerhays Planetarium, Brigham Young Univ., 492 ESC, 84602, (801) 378-2805, 24' dome theater (Goto Venus), observatory (14" SCT), exhibits. Open Fri. evenings and by reservation. Program info. line: 378-5396.

Salt Lake City: Hansen Planetarium, 15 South State St., 84111, (801) 538-2104, 50' dome theater (Digistar), exhibits, tours, laser shows. Open daily.

VERMONT

Williston: Green Mountain Observatory II, P.O. Box 782, 05495, (802) 985-3269, observatory (16" Tri-schiefspiegler), public observing. Open by reservation.

VIRGINIA

Arlington: Arlington Planetarium, 1426 North Quincy St., 22207, (703) 358-6070, 30' dome theater (Spitz A4RPY), observatory (10" reflector). Not open in summer.

Ashland: Keeble Observatory, Randolph-Macon College, 23005, (804) 752-7344, observatory (12" reflector). Open weekly Sept. - May. Open during summer by reservation. Program info. line: 798-8372 x578.

Charlottesville: Leander McCormick Observatory, Univ. of Virginia, P.O. Box 3818, 22903, (804) 924-7494, 26" Clark refractor. Public observing first and third Fri. of each month through summer.

Chesapeake: Chesapeake Planetarium, 300 Cedar Rd., 23320, (804) 547-0153, 30' dome theater (Spitz A3P), observatory (14" SCT). Open Mon. - Fri.

Hampton: NASA Langley Research Center, MS 480, 23665, (804) 864-6000, visitor center, exhibits, tours by reservation. Open daily.

Harrisonburg: M.T. Brackbill Planetarium, Eastern Mennonite College, 22801, (703) 432-4400, 30' dome theater, observatory (8" scope). Open by reservation. Not open in summer.

Harrisonburg: John C. Wells Planetarium, James Madison Univ., Miller Hall, 22801, (703) 568-3845, 30' dome theater (Goto 10). Open Thurs. evenings. Program info. line: 568-7827.

Newport News: Virginia Living Museum Planetarium, 524 J. Clyde Morris Blvd., 23601, (804) 595-1900, 30' dome theater (Spitz A3P), observatory (14" SCT), exhibits. Open daily.

Richmond: Ethyl Universe Space Theater, Science Museum of Virginia, 2500 West Broad St., 23220, (804) 367-0211, 76' dome theater (Digistar), OMNIMAX® films, exhibits. Open daily in summer. Program info. line: 367-0000.

Roanoke: Science Museum of Western Virginia/Hopkins Planetarium, Center in the Square, One Market Square, 24011, (703) 342-5710, 40' dome theater (Spitz 512), public observing (17" Dobsonian), Cinema 360°, exhibits, laser shows. Open daily except holidays.

Virginia Beach: Virginia Beach City Public Schools Planetarium, 3080 South Lynnhaven Rd., 23452, (804) 431-4067, 40' dome theater (Spitz A4), 3 reflectors, exhibits. Not open in July.

Wallops Island: NASA Wallops Flight Facility, Bldg. J-17, 23337, (804) 824-2297, exhibits, tours. Open daily in summer.

WASHINGTON

Bellingham: Western Washington Univ. Planetarium, Physics Dept., 98225, (206) 676-3818, 24' dome theater (Spitz A2). Open by reservation.

Goldendale: Goldendale Observatory, 1602 Observatory Dr., 98620-3315, (509) 773-3141, observatory (24.5" Cassegrain), exhibits, tours. Open Apr. - Sept. 2 - 5 p.m. and 7 p.m. - midnight Wed. - Sun.

Pullman: Planetarium, Washington State Univ., Dept. of Physics, 99163-3113, (509) 335-8518, 24' dome theater (Spitz A3P), observatory (12" refractor). Open by reservation.

Seattle: Willard W. Smith Planetarium, Pacific Science Center, 200 Second Ave. North, 98109, (206) 443-2001, 27' dome theater (Spitz 512), exhibits, IMAX® theater, laser shows. Open daily except Thanksgiving and New Year's Day. Program info. line: 443-2920.

WEST VIRGINIA

Charleston: Sunrise Planetarium, 746 Myrtle Rd., 25314, (304) 344-8035, 24' dome theater (Spitz A3P), observatory (10" SCT). Open first and third Sat. 11:00 a.m. and 2:00 p.m. and second and fourth Fri. 7:30 p.m.

Elkins: Flynn Planetarium, Davis and Elkins College, 100 Sycamore St., 26241, (304) 636-1900, 25' dome theater (Goto Venus). Open by reservation.

Green Bank: National Radio Astronomy Observatory, P.O. Box 2, 24944, (304) 456-2011, exhibits, tours. Open daily in summer. Open weekends Sept. - Oct. Program info. line: 456-2209.

Hedgesville: Berkeley County Planetarium, Hedgesville High School, Rt. 1, Box 89, 25427, (304) 754-3354, 20' dome theater (Spitz 373), 8" SCT, solar scopes. Not open in summer.

Parkersburg: Dwight O. Connor Planetarium, Parkersburg High School, 2101 Dudley Ave., 26101, (304) 420-9595, 27' dome theater (Spitz A3P). Open 9 and 10 a.m. and 1 p.m. during school year; open by reservation in summer.

Wheeling: Benedum Natural Science Center, Oglebay Resort and Conference Center, 26003, (304) 243-4034, 40' dome theater (Spitz 512a), observatory (4" and 10" scopes), Cinema 360°, laser shows. Open daily.

WISCONSIN

Eau Claire: L. E. Phillips Planetarium, Univ. of Wisconsin - Eau Claire, 54702-4004, (715) 836-5731, 24' dome theater (Spitz A3P). Open Sept. - May.

Fall Creek: Hobbs Observatory, Beaver Creek Reserve, Route 2, Box 94, 54742, (715) 877-2787, 24" reflector. Open every clear Sat. night May - Oct.

La Crosse: Planetarium, Univ. of Wisconsin- La Crosse, Cowley Hall, 54601, (608) 785-8669, 24' dome theater (Spitz A3P), 13" reflector. Not open in summer.

Madison: UW Space Place, 1605 S. Park St., 53715, (608) 262-4779, public astronomy lectures and children's workshops.

Madison: Washburn Observatory, Univ. of Wisconsin-Madison, 475 N. Charter, 53706-1582, (608) 262-3072, observatory (15" refractor), exhibits. Program info. line: 262-3071. Viewing info. line: 262-9274.

Menasha: UW Fox Planetarium, Univ. of Wisconsin-Fox Valley, 1478 Midway Rd., 54952, (414) 832-2600, 25' dome theater (Spitz A3P), exhibits. Public observing sessions by reservation only. Program info. line: 832-2848.

Milwaukee: Manfred Olson Planetarium, Univ. of Wisconsin - Milwaukee, 1900 East Kenwood, 53211, (414) 229-4961, 30' dome theater (Spitz A3P). Not open in summer.

Stevens Point: Planetarium, Univ. of Wisconsin-Stevens Point, 740 Reserve St., 54481, (715) 346-2208, 25' dome theater (Spitz A3P), observatory (16" SCT). Open Wed. evenings and Sat. afternoons during school year and also by reservation.

Williams Bay: Yerkes Observatory, 373 W. Geneva St., P.O. Box 258, 53191-0258, (414) 245-5556. Largest refractor (40") in the world. Tours: from June - Sept.: open Sat. 1:30 - 4 p.m.; from Oct. - May: open Sat. 10 - noon. Program info. line: 245-5555.

WYOMING

Casper: Casper Planetarium, 904 North Poplar St., 82601, (307) 557-0310, 30' dome theater (Spitz A3P), various scopes. Open Mon. - Fri. 8:30 a.m. to 3:30 p.m., planetarium shows 7:30 p.m. and 8:00 p.m.

Laramie: Univ. of Wyoming Planetarium, Dept. of Physics and Astronomy, Univ. Station, Box 3905, 82071, (307) 766-6150, 40' dome theater (Spitz), observatory (16" Cassegrain). Open every Fri. during academic year.

Laramie: Wyoming Infrared Observatory, Univ. of Wyoming, Univ. Station, Box 3905, 82071, (307) 766-6150.

CANADA

ALBERTA

Calgary: Alberta Science Centre, 701–11 St. SW, T2P 2M5, (403) 221-3713, 65' dome theater (Zeiss Digistar), exhibits. Open daily except Mon. and Tues. in winter. Program info. line: 221-3700.

Calgary: Rothney Astrophysical Observatory, Physics Dept., Univ. of Calgary, T2N 1N4, (403) 220-5392, 1.8-meter scope. Open by reservation.

Edmonton: Edmonton Space and Science Centre, 11211–142 St., T5M 4A1, (403) 452-9100, 76' dome theater (Zeiss Jena Cosmorama), observatory (14" SCT), IMAX® theatre, exhibits, Challenger Learning Center. Open daily except non-holiday Mon. during winter. Program info. line: 451-7722.

Edmonton: Physics Dept. Observatory, Univ. of Alberta, T6G 2J1, (403) 492-5287, observatory (14" and 12" scopes), exhibits. Open Fri. during academic year and by reservation. Program info. line: 492-5410.

BRITISH COLUMBIA

Penticton: Dominion Radio Astrophysical Observatory, Windlake Rd., Box 248, V2A 6K3, (604) 493-2277, 26-meter radio dish, 600-meter synthesis array, exhibits, self-guided tours Sun. 2 to 5 p.m. Open daily, daytime only.

Vancouver: H.R. MacMillan Planetarium and Gordon Southam Observatory, 1100 Chestnut St., V6J 3J9, (604) 736-4431, 65' dome theater (Zeiss Jena Universal), observatory (20" Cassegrain). Open Tues. - Sun. Sept. - June. Program info. line: 736-3656.

Vancouver: Science World, 1455 Quebec St., V6A 3Z7, (604) 687-8414, exhibits, OMNIMAX® theatre. Open daily in summer, daytime only. Program info. line: 687-7832.

Vancouver: Univ. of British Columbia Observatory, 2219 Main Mall, V6T 1W5, (604) 228-2802, 16" scope. Open clear Sat. evenings. Call 228-6186 to confirm.

Victoria: Climenhaga Observatory, Dept. of Physics and Astronomy, Univ. of Victoria, V8W 3P6, (604) 721-7750, 20" scope. Open by reservation.

Victoria: Dominion Astrophysical Observatory, 5071 West Saanich Rd., V8X 4M6, (604) 363-0001, 1.85-meter reflector, exhibits, tours. Open daily in Summer; weekends, fall - spring.

MANITOBA

Winnipeg: Lockhart Planetarium, U. of M., 394 University College, 500 Dysart Rd., R3T 2M8, (204) 474-9785, 26' dome theater (Spitz A3P). Open by reservation.

Winnipeg: Manitoba Planetarium, Museum of Man and Nature, 190 Rupert Ave., R3T 0E1, (204) 956-2830, 60' dome theater (Zeiss VS). Open daily except Mon. in the winter. Program info. line: 943-3142.

NOVA SCOTIA

Halifax: Burke-Gaffney Observatory, Saint Mary's Univ., B3H 3C3, (902) 420-5633, observatory (16" Cassegrain), slide shows. Open first and third Sat. and also by reservation.

Halifax: Halifax Planetarium, Nova Scotia Museum, Summer St., B3H 3A6, (902) 429-4610, Located at Sir James Dunn Building, Dalhousie Univ. Open by reservation.

ONTARIO

Hamilton: McMaster Univ. Planetarium, 1280 Main St. West, L8S 4M1, (416) 525-9140, 24' dome theater. Open by reservation.

Ottawa: National Museum of Science and Technology, 1867 St. Laurent Blvd., K1G 5A3, (613) 991-9219, exhibits, Starlab planetarium, observatory (15" refractor). Public observing every Tues. evening (in French) and every Wed. and Thurs. evening (in English) during July and Aug.

Richmond Hill: David Dunlap Observatory, P.O. Box 360, 123 Hillsview Dr., L4C 4Y6, (416) 884-9562, observatory (74" reflector), tours. Open by reservation. Program info. line: 884-2112.

Sudbury: Science North Solar Observatory, 100 Ramsey Lake Rd., P3E 5S9, (705) 522-3701, exhibits, solar observatory with 17.5" heliostat. Open daily except Christmas and New Year's Day.

Toronto: McLaughlin Planetarium, Royal Ontario Museum, 100 Queen's Park, M5S 2C6, (416) 586-5737, 75' dome theatre (Zeiss Universal), laser shows, exhibits. Open daily in summer except for non-holiday Mon. Program info. line: 586-5736.

Toronto: Ontario Science Centre, 770 Don Mills Rd., M3C 1T3, (416) 429-4100, 24' dome theater (Zeiss), exhibits, Challenger Learning Centre. Open daily except Christmas. Program info. line: 696-3127 (English), 696-3147 (French).

QUÉBEC

Montréal: Dow Planetarium, 1000 St. Jacques Ouest, H3C 1G7, (514) 872-4530, 65' dome theater (Zeiss V), exhibits. Open daily except Mon. Alternating schedule of French and English programs.

Notre Dame Des Bois: Mont Megantic Observatory, Chemin des Bois, J0B 2E0, (819) 888-2755, 63" reflector, exhibits, tours. Open daily in summer.

SASKATCHEWAN

Regina: Kalium Observatory, Saskatchewan Science Centre, Winnipeg St. and Wascana Dr., P.O. Box 5071, S4P 3M3, (306) 791-7900, observatory (6" refractor), IMAX®, interactive science exhibits. Open daily. Program info. line: 352-5811.

Saskatoon: Univ. of Saskatchewan Observatory, Physics Dept., S7N 0W0, (306) 966-6396, observatory (6" refractor). Open Sat. evenings.

MÉXICO

Enseñada: Observatorio Astronómico Nacional, Carretera Tijuana-Enseñada Km. 103.5, Apartado Postal 877, BC, 22860.

Enseñada: Observatorio de San Pedro Martir, Instituto de Astronomía, Apartado Postal 877, BC, 22860, (706) 678-3448.

Hermosillo: Estacion de Observacion, Eos-Cifus, Universidad de Sonora, Rosales y Transversal, Apartado Postal 5-088, Sonora 83190, 62-126649, observatory (5.5" refractor), two 10 heliostats, tours. Open daily.

Hermosillo: Observatorio Astronómico del Centro Ecologico de Sonora, Oaces, Centro Ecologico de Sonora, Sonora, (62) 126649, observatory (16" Cassegrain). Open Wed. - Sat. Not open in summer. Program info. line: 62-50-1137.

Monterrey: Centro Cultural Alfa, Apartado Postal 1177, NL, 64000, 83-565105, 76' dome theater (Spitz STS), observatory (8" Cassegrain), OMNIMAX®, films, exhibits, tours. Open daily except Mon. Program info. line: 83-565165.

ASTRONOMY CLUBS

Over 36,000 amateur astronomers in North America belong to local or regional astronomy clubs. Clubs provide expert advice, instructional courses and meetings, access to libraries, telescopes, and observatories, and lots of comaraderie with people who share a love of the stars. Many clubs hold regular public viewing nights and star parties for area amateurs. These are often held at local planetariums or parks or at observatories operated by the individual clubs.

Our listing contains nearly 500 clubs in North America. Why not scan down the list and give your local club a call to find out what they have planned for activities this year? Even if you choose not to join a club, you may still find attending one of its events a great way to expand your hobby.

If your local club is not included on our list, please contact us so we can update our database.

UNITED STATES

ALABAMA

Auburn: Auburn Astronomical Society, 748 E. Magnolia Ave., 36830, Jim Chestnutt, (205) 821-1062, 20 members.

Birmingham: Birmingham Astronomical Society, P.O. Box 36311, 35236, Bob Bruening, (205) 991-0862. Founded 1979, 54 members, observatory with 16" scope.

Huntsville: Von Braun Astronomical Society, Box 1142, 35807, Dennis Culver, (205) 882-2508. Founded 1954, 150 members, observatory with 18" scope. Monthly public viewing nights.

Mobile: Mobile Astronomical Society, P.O. Box 160972, 36616, Pat Rochford, (205) 471-5954. Founded 1983, 40 members, observatory with 12.5" reflector. Public viewing nights.

Tuscumbia: Muscle Shoals Astronomical Society, 302 N.E. Commons, 35674, Homer Russell, Jr., (205) 383-6717. Founded 1959, 10 members, observatory with 10" Springfield reflector. Public viewing nights.

ALASKA

Fairbanks: Astronomical Units, Box 82210, 99708, Robert E. Fischer, (907) 456-6586. Founded 1986, 15 members, observatory with 14" SCT.

ARIZONA

Flagstaff: Coconino Astronomers, 220 West Cherry Avenue, #210, 86001, Ralph Aeschliman, (602) 779-3431. Founded 1992, 15 members.

Grand Canyon: Astronomical Society of the Grand Canyon, P.O. Box 1515, 86023, Larry Noon, (602) 638-2263.

Green Valley: Sonora Astronomical Society, 101 Verde Vista, 85614, J.R. Andress, (602) 625-8324. Founded 1985, 68 members.

Mesa: East Valley Astronomy Club, 1836 N. Stapley Dr., #100, 85203, Ted Heckens, (602) 827-1524. Founded 1987, 70 members. Sponsors All-Arizona Star Party.

Phoenix: Phoenix Astronomical Society, 518 W. Coronado Rd., 85003, Kai Staats, (602) 253-3077. Founded 1948, 50 members.

Phoenix: Phoenix Youth Astronomical Network, 3744 W. Brown, 85051-1140, John Barentine. Founded 1990, 8 members.

Phoenix: Saguaro Astronomy Club, 19026 N. 34th Dr., 85027, Robert Dahl, (602) 582-5526. Founded 1977, 120 members. Sponsors Sentinel Star Party.

Prescott: Prescott Astronomy Club, 615 Cricket Circle, 86301, Linda Gaul. 20 members.

Sedona: Verde Valley Astronomy Club, 115 White Horse Way, 86336, Barbara Westhafer, (602) 284-9167. Founded 1990, 25 members. Hosts annual astronomy festival at Red Rock State Park and star show at Verde River Days Celebration.

Sierra Vista: Huachuca Astronomy Club, 3395 Briarwood Dr., 85635, Ray Perger, 20 members.

Sun City West: Astronomy Club of Sun City West, 17802 131st Ave., 85375, Jim Crisman, (602) 584-0896. Founded 1986, 150 members.

Tucson: Tucson Amateur Astronomy Assoc., P.O. Box 41254, 85717, Dean Ketelson, (602) 293-2855. Founded 1954, 180 members, observatory with 16" scope.

ARKANSAS

Dover: River Valley Stargazers, P.O. Box 261, 72837, Rex McDaniel, (501) 331-3773. Founded 1990, 12 members, observatory with 20" scope. Hosts Mt. Magazine Star Party.

Fayetteville: Astronomical Society of Northwest Arkansas, 2503 Sweetbriar Dr., 72703, Betty Davis, (501) 442-2833. Founded 1977, 30 members.

Fort Smith: Arkansas-Oklahoma Astronomical Society, P.O. Box 31, 72902, Joe Roam, (501) 474-4740. Founded 1985, 30 members, observatory with 29" Newtonian. Hosts annual Arkansas Star Party.

Hot Springs Village: Village Star Gazers Society, 13 Tarifa Lane, 71909, Dorothy Kegerreis. Founded 1990, 15 members.

Roland: Mid-South Astronomical Society, P.O. Box 38, 72135, Bruce McMath, (501) 372-1367. Founded 1970, 35 members, observatory with 12.5" scope.

Texarkana: Red River Astronomy Club, 4808 Sunbury, 75502, Ken White, (501) 772-4200. Founded 1985, 10 members.

CALIFORNIA

Apple Valley: Bear Valley Astronomical Society, 15191 Nokomis Rd., 92307.

Apple Valley: High Desert Astronomical Society, P.O. Box 2968, 92307, Laurie Allen, (619) 949-3077. Founded 1990, 75 members, observatory with 14" SCT. Public viewing nights.

Aptos: Cabrillo Astronomical Stargazing Society, Cabrillo College, 6500 Soquel Dr., 95003, Karl von Ahnen. Founded 1985, 24 members. Monthly star parties at Cabrillo College Observatory.

Bakersfield: Kern Astronomical Society, 5209 Greenbriar, 93306, John Witt, (805) 871-2692. Founded 1955, 60 members.

Chatsworth: Celestial Observers, 9534 Gierson Ave., 91311, Michael Selden, (818) 882-6172. Founded 1975, 12 members.

Costa Mesa: Orange County Astronomers, 2195 Raleigh Ave., 92627, John Sanford, (714) 722-7900. Founded 1967, 610 members, observatory with 22" Cassegrain.

Eureka: Astronomers of Humboldt, P.O. Box 351, 95502, Robert Zigler, (707) 768-3296. Founded 1957, 25 members.

Fallbrook: Oceanside Photo and Telescope Astronomical Society, 929 Buena Rosa Ct., 92028, Penny Hauck, (619) 723-0684. Founded 1984, 170 members. Hosts annual Oceanside Star Party.

Fresno: Central Valley Astronomers, P.O. Box 5013, 93755, Clarence Funk, (209) 291-7879. Founded 1952, 60 members.

Glen Ellen: Valley of the Moon Astronomical Society, P.O. Box 999, 95442, Al Heppe, (707) 996-1246. Founded 1980, 16 members, observatory with 40" scope. Monthly star parties.

Hemet: Hemet Astronomical Society, 334 Hillview Dr., 92544, Ralph L. Shook.

Idyllwild: Idyll-Gazers Astronomy Club, P.O. Box 1245, 92549, Joe Neu, (909) 659-3562. Founded 1978, 50 members. Monthly star parties.

Joshua Tree: Andromeda Astronomical Society, 56089 29 Palms Hwy., Suite 455, Yucca Valley, 92284, Sam Davidson. Founded 1975, 20 members. Monthly star parties at Joshua Tree National Monument.

Lake Arrowhead: Mountain Skies Astronomical Society, P.O. Box 1169, 92352, Lorann Parker, (909) 337-4075. Founded 1989, 1,400 members. Hosts starwatches. Hotline: (909) 336-1299.

Lakewood: Excelsior Telescope Club, 3519 St. Pancratius Place, 90712, Rev. Ronald Royer, (310) 634-6111. Founded 1939, 20 members, observatory with 18" Newtonian.

Lancaster: Antelope Valley Astronomy Club, P.O. Box 426, 93584, Steve Lanterman, (805) 727-0016. Founded 1982, 25 members.

Livermore: Tri-Valley Stargazers, P.O. Box 2476, 94551, Alan Gorski, (510) 828-3278. Founded 1979, 140 members, observatory with 17" scope.

Los Angeles: Los Angeles Astronomical Society, 2800 E. Observatory Rd., 90027, Roger Keen, (213) 727-7909. Founded 1926, 350 members, observatory with 31" reflector. Hotline: (213) 727-7909.

Martinez: Mt. Diablo Astronomical Society, 1416 Flintwood Ct., 94553, Joseph Heckenbach, (510) 229-3417. Founded 1957, 85 members.

Mill Valley: Marin Stargazers, 27 Morning Sun, 94941, R. Parlette.

ASTRONOMY CLUBS

Monterey: Monterey Institute for Research in Astronomy, P.O. Box 1551, 93941, Stew Hobson, (408) 373-7560. Founded 1983, 40 members. Public star parties.

Mountain View: Peninsula Astronomical Soc., P.O. Box 4542, 94040, Bill Sorrells, (415) 370-1215.

Murrieta: Temecula Valley Astronomers, P.O. Box 986, 92564, Doug Pifer, (909) 677-1148. Founded 1991, 30 members.

Newhall: Local Group of Santa Clarita Valley, 25032 Walnut St., 91321, LaVerne Booth, (805) 259-3284. Founded 1984, 80 members.

Oakland: Astronomical Association of Northern California, 4917 Mountain Blvd., 94619, Don Stone, (510) 376-3007. Founded 1971, 22 members, observatory, Astronomy Day program.

Oakland: Chabot Telescope Makers Workshop, 4917 Mountain Blvd., 94619.

Oakland: Eastbay Astronomical Society, 4917 Mountain Blvd., 94619, Carter Roberts, (510) 524-2146. Founded 1924, 200 members.

Palm Desert: Astronomical Society of the Desert, College of the Desert, 43-500 Monterey Ave., 92260, Ashley McDermott, (619) 346-2524. Founded 1972, 65 members.

Pasadena: Caltech SEDS, Make Code 112-58, Calif. Inst. of Tech., 91125, Ben McCall, (818) 683-0750. Founded 1986, 100 members.

Richmond: Hercules Stargazers, 6102 Sacramento Avenue, 94804, David L. Harris, (510) 526-5974. Founded 1990, 11 members.

Ridgecrest: China Lake Astronomical Society, P.O. Box 1783, 93555, Roger Brower, (619) 375-3697. Founded 1958, 70 members. Monthly public star party.

Riverside: Riverside Astronomical Society, P.O. Box 51222, 92517. Founded 1957, 100 members. Co-hosts annual Riverside Telescope Makers Conference. Hotline: (714) 689-0116.

Rocklin: Sacramento Valley Astronomical Society, P.O. Box 575, 95677, Larry Harrison, (916) 726-7300. Founded 1945, 300 members, observatory with 16" scope. Public viewing nights.

San Anselmo: Tamalpais Astronomical Society, 31 Crane Dr., 94960.

San Bernardino: San Bernardino Amateur Astronomers, 1345 Garner Ave., 92411, David E. Garcia, (909) 884-0657. Founded 1956, 65 members. Co-hosts Riverside Telescope Makers Conference.

San Diego: San Diego Astronomy Assoc., P.O. Box 23215, 92193, Greg Cade, (619) 495-1787. Founded 1963, 320 members, observatory with 22" scope. Public viewing nights.

San Diego: San Diego L5 Society, P.O. Box 4636, 92164, Leonard McVicker. Founded 1982, 52 members.

San Francisco: San Francisco Amateur Astronomers, Morrison Planetarium, Golden Gate Park, 94118, Bob Levenson, (415) 750-7127. Founded 1952, 160 members, observatory with 25" scope. Monthly star parties on Mt. Tamalpais.

San Francisco: STARS, City College of San Francisco, 50 Phelan Ave., 94112, Don Warren, (415) 239-3242. Founded 1950, 20 members, observatory with 14" SCT. Student club.

San Jose: San Jose Astronomical Assoc., 3509 Calico Ave., 95124, Jim Van Nuland, (408) 371-1307. Founded 1954, 250 members. Monthly star parties at Houge City Park. Hotline: (408) 559-1221.

San Juan Bautista: Fremont Peak Observatory Assoc., P.O. Box 1110, 95045, Rick Morales, (408) 623-4255. Founded 1985, 150 members, observatory with 30" Newtonian. Public observing nights.

San Luis Obispo: Central Coast Astronomical Society, P.O. Box 1415, 93406, Lee Coombs, (805) 466-2788. Founded 1969, 60 members.

San Marcos: Astronomical Society of Southern California, P.O. Box 2046, 92069, Michael Wartenberg, (619) 741-6128.

San Mateo: San Mateo Astronomical Society, P.O. Box 974, Station A, 94403, Bob Bruynesteyn, (415) 349-3743. Founded 1960, 50 members.

San Rafael: Mt. Tam Observers, 89 Dominican Dr., 94901, Tinka Ross, (415) 454-4715. Monthly public viewing, April through October.

Santa Barbara: Astronomical Unit, 2559 Puesta del Sol, 93105, Fred Marshak, (805) 682-3224. Founded 1984, 125 members, observatory with 29" reflector. Public viewing nights. Hotline: (805) 682-3224.

Santa Barbara: Santa Barbara Astronomy Club, P.O. Box 3702, 93130, Clyde Kirkpatrick, (805) 966-3695. Founded 1958, 52 members, observatory with 16.5" scope. Public viewing nights. Hosts annual Perseid Meteor Star Party.

Santa Cruz: Santa Cruz Astronomy Club, L-2 San Carlos Lane, 95065, Mary Ignizio, (408) 475-4120. Founded 1979, 68 members.

Santa Monica: Santa Monica Amateur Astronomy Club, 1415 Michigan Ave., 90404, Robert Lozano, (310) 450-1944. Founded 1981, 40 members. Sponsors Richard Reeve Star Party at Charmlee State Park.

Santa Rosa: Sonoma County Astronomical Society, P.O. Box 183, 95402, G. Ed Megill, (707) 795-7829. Founded 1974, 200 members.

Simi Valley: Ventura County Astronomical Society, P.O. Box 982, 93062, Rick Williams, (805) 523-3066, 110 members.

Sonora: Sonora Astronomical Society, 21581 Phoenix Lake Rd., 95370, Lance Kearns. Founded 1987, 30 members, observatory with 18" scope. Public viewing nights. Hosts Globular and Open Cluster Hunt.

Stockton: Stockton Astronomical Society, P.O. Box 243, 95201, Ed Rible, (209) 478-5795. Founded 1950, 65 members.

Tulare: Tulare Astronomical Assoc., P.O. Box 515, 93275, George Thrasher, (209) 686-5669. Founded 1968, 85 members, observatory, 10" Newtonian. Host star parties.

Upland: Pomona Valley Amateur Astronomers, P.O. Box 162, 91786, Harvard Pennington, (714) 983-7308, 200 members.

Van Nuys: Los Angeles Valley College Astronomy Club, 5800 Fulton Ave., 91401, Bruce Dale, (818) 781-1200. Founded 1985, 30 members.

Vandenberg AFB: Vandenberg Amateur Astronomical Society, P.O. Box 5321, 93437, Bob Karl, (805) 733-4390. Founded 1985, 20 members, observatory with 14" SCT. Public viewing nights.

Waterford: Stanislaus Amateur Astronomers, 12129 Washburn Ave., 95386, Howard Wilson, (209) 874-4313. Founded 1989, 35 members, observatory with 14" SCT. Monthly public viewing nights.

Whittier: Western Observatorium, 14517 E. Broadway, 90604, Roger Wilcox, (213) 941-9755. Founded 1975, 40 members. Hosts annual Telescope Users Clinic.

Woodland Hills: Polaris Astronomical Assoc., 22018 Ybarra Rd., 91364, Ray Coutchie, (818) 347-8922. Founded 1965, 45 members, observatory with 12" scope. Public viewing nights.

COLORADO

Colorado Springs: Colorado Springs Astronomical Society, P.O. Box 62022, 80962, Jim Lawrence, (719) 593-0801. Founded 1985, 50 members. Hosts annual Summer Star Stare.

Colorado Springs: Rocky Mountain Astrophysical Group, 12815 Porcupine Lane, 80908, Paul Van Slyke, (719) 495-3828. Founded 1987, 100 members, observatory with 30" scope. Public viewing nights.

Denver: Denver Astronomical Society, Chamberlin Observatory, 2930 E. Warren Ave., 80210, Dave Trott, (303) 871-5172. Founded 1947, 150 members, Chamberlain Observatory (20" Clark refractor).

Elbert: High Plains Astronomy Club, 13265 Bozeman Trail, 80106, Mike Silva, (719) 495-0873. Founded 1990, 8 members, observatory with 11" scope. Public viewing nights.

Grand Junction: Western Colorado Astronomy Club, P.O. Box 55032, 81505, Harry Brauneis, (303) 285-9553. Founded 1989, 31 members.

Longmont: Longmont Astronomical Society, P.O. Box 8029, 80501, Bob Spohn, (303) 772-1470. Founded 1986, 40 members.

Pueblo: Southern Colorado Astronomical Assoc., 2801 8th Ave., 81003, Mike Bosley, 6 members.

CONNECTICUT

Milford: Astronomical Society of New Haven, 20 Mark Street, 06460, Linda Marks (203) 874-4816. Founded 1937, 90 members.

New Haven: Astronomical Society of New Haven, P.O. Box 3005, 06515, Linda Marks, (203) 874-4816. Founded 1937, 81 members, observatory with 10" scope. Monthly public star parties. Hosts Connecticut Star Party.

Oakdale: Thames Astronomical Society, 55 Doyle Rd., 06370, Kathleen Audette, (203) 859-0071. Founded 1974, 23 members.

Stamford: Fairfield County Astronomical Society, Stamford Museum Observatory, 39 Scofieldtown Rd., 06903, Charles Scovil, (203) 322-1648. Founded 1954, 76 members, observatory with 22" Maksutov.

Stratford: Boothe Memorial Astronomical Society, 114 King's College Place, 06497, Vincent Manjoney, (203) 375-9673. Founded 1955, 20 members, observatory with 16" scope. Public viewing nights.

Torrington: Litchfield Hills Amateur Astronomy Club, 361 Funston Ave., 06790, David H. Wheeler, (203) 489-8898. Founded 1956, 30 members. Monthly star parties.

Waterbury: Mattatuck Astronomical Society, Mattatuck Community College, 750 Chase Parkway, 06708, J. Lawrence Pond, (203) 575-8236. Founded 1985, 78 members, observatory with 14" SCT. Public viewing nights.

West Hartford: Astronomical Society of Greater Hartford, Grengras Planetarium, 950 Trout Brook Dr., 06119, Jay Sottolano, (203) 651-0096. Founded 1955, 160 members.

Westport: Westport Astronomical Society, P.O. Box 5118, 06881, Bob Deedan, (203) 226-8812. Founded 1975, 70 members, observatory with 12.5" scope. Public viewing nights.

DELAWARE

Hockessin: Delaware Astronomical Society, P.O. Box 652, 19899, Henry Bouchelle, (302) 654-6407. Founded 1957, 155 members, 36" scope.

Wilmington: Mount Cuba Astronomical Observatory, P.O. Box 3915, Hillside Hill Rd., Greenville, 19807, Grace Quirk, (302) 654-6407. Founded 1958, 300 members, observatory with 24" scope. Public viewing nights and children's camps.

FLORIDA

Altamonte Springs: Central Florida Astronomical Society, P.O. Box 161590, 32716, Jerry Reed, (407) 886-3770. Founded 1977, 125 members.

Bradenton: Local Group of Deep-Sky Observers, 2311 23rd Ave. West, 34205, Vic and Lynne Menard, (813) 747-8334. Founded 1983, 100 members.

Chiefland: Astro Scopers, R 1 Box 302-C, 32626, Sparky Talios, (904) 493-4359. Founded 1992, observatory with 14" scope. Public viewing nights. Sponsors Chiefland Star Fest.

Cocoa: Brevard Astronomical Society, P.O. Box 1084, 32923, Yerby Land, (407) 724-5681. Founded 1972, 39 members.

Englewood: Lemon Bay Astronomy Club, Lemon Bay High School, 2201 Placida Rd., 34223, Frank Lock, (813) 475-1578. Founded 1989, 20 members. Open to high school students only.

Fort Lauderdale: South Florida Amateur Astronomers Assoc., 16001 W. State Rd. 84, 33326, Phil Hauger, (305) 721-4159. Founded 1966, 70 members. Public viewing nights.

Fort Myers: Southwest Florida Astronomical Society, P.O. Box 6583, Miracle Mile Station, 33911, Alan Goldman, (813) 495-2000. Founded 1980, 40 members.

Fort Pierce: Treasure Coast Astronomical Society, 131 Queen Catherina Ct., 34949, Walter Swentzell, (407) 465-4454. Founded 1983, 30 members. Hotline: (407) 465-4454.

Gainesville: Alachua Astronomy Club, P.O. Box 12247, 32604, Jeff Majewski, (904) 475-1014. Founded 1987, 37 members.

Jacksonville: Northeast Florida Astronomical Society (NEFAS), P.O. Box 16574, 32245, Roger Curry, (904) 398-1335. Founded 1976, 80 members, observatory with 14.5" scope. Public viewing nights.

Largo: Tampa Area Astronomy Society, 9890 82nd St. N., 34647, John Novak, (813) 392-4699. Founded 1951, 45 members, observatory with 20" reflector.

Melbourne: Society for Astronomy and Space Sciences, Florida Institute of Technology, Physics/Space Science Dept., 32901, Michael Adams, (407) 768-8000, 40 members, observatory with 14" SCT.

Miami: Belen Jesuit Prep School Astronomy Club, 500 SW 127th Ave., 33184, Leo Nunez, (305) 223-8600. Founded 1979, 30 members, observatory with 8" scope. Public viewing nights.

Miami: Southern Cross Astronomical Society, 13841 SW 106 St., 33186, Robert Ward, (305) 385-5021. Founded 1922, 160 members, observatory with 14" SCT. Public viewing nights. Sponsors Winter Star Party.

Naples: Everglades Astronomical Society, 780C Meadowland Dr., 33963, Peter Wlasuk, (813) 597-5088. Founded 1980, 50 members.

Palm Beach Gardens: Astronomical Society of the Palm Beaches, P.O. Box 30023, 33420, Elizabeth Long, (407) 746-8064, 80 members.

Panama City: Astronomical Society of Bay County, P.O. Box 16356, 32405, Bob Gent, (904) 784-1603. Re-established 1991, 50 members.

Pensacola: Escambia Amateur Astronomers, 6235 Omie Circle, 32504-7625, Wayne Wooten, (904) 477-8859. Founded 1976, 150 members, observatory, 16" scope.

Sebring: Highlands Stargazers, 2130 Gresham Street, 33872, Richard Lindblom (813) 655-0131. Founded 1988, 15 members. Host monthly star parties.

St. Augustine: Ancient City Astronomy Club, P.O. Box 546, 32085, A. L. Ponjee. Founded 1974, 20 members.

St. Petersburg: St. Petersburg Astronomy Club, 594 59th St. S, 33707, Daniel W. Bricker, (813) 343-1594. Founded 1927, 140 members. Operates Hickory Hill Observing Complex.

Tallahassee: Tallahassee Astronomical Society, 611 Richardson Rd., 32301, Joseph Haley, (904) 386-1874. Founded 1990, 35 members, observatory with 14" SCT. Public viewing nights.

Tampa: Museum Astronomy Resource Society (MARS), 2602 E. 98th Ave., 33612, Craig MacDougal, (813) 933-9617. Founded 1984, 30 members.

GEORGIA

Athens: Athens Astronomical Assoc., Plantation Dr., 30605, Maurice E. Snook, (706) 543-3753. Founded 1977, 5 members.

Atlanta: Astronomical Society of the Atlantic, P.O. Box 15038, 30333, Ingrid Tanghe, (404) 873-1453. Founded 1988, 200 members. Hosts annual Georgia Star Party. Hotline: (404) 264-0451.

Atlanta: Atlanta Astronomy Club, P.O. Box 29631, 30359-0631, Bud Rosser, (404) 873-0304. Founded 1948, 140 members, observatory with 20" scope.

Augusta: Astronomy Club of Augusta, P.O. Box 6373, 30916, John T. White, (404) 860-6115. Founded 1986, 40 members.

Columbus: Chattahoochee Valley Astronomical Society, c/o Patterson Planetarium, 2900 Woodruff Farm Road, 31907, Clay Powers, (706) 569-2549. Founded 1992, 25 members.

Macon: Middle Georgia Astronomical Society, Museum of Arts and Sciences, 4182 Forsyth Rd., 31210, Gary L. Kretsinger, (912) 956-2145.

Savannah: Oglethorpe Astronomical Assoc., Savannah Science Museum, 4405 Paulsen St., 31405, Vickie Watson, (912) 355-6705. Founded 1968, 25 members.

HAWAII

Hilo: Mauna Kea Astronomical Society, 175 Banyan Dr., #217, 96720, Bruce Marten, (808) 969-7357. Founded 1985, 15 members. Monthly public viewing nights at Hale Pohaku (9,000' level) on Mauna Kea.

Honolulu: Hawaiian Astronomical Society, P.O. Box 17671, 96817, Peter Galloway. Founded 1949, 245 members, observatory with 12" scope. Monthly public viewing nights.

Pu'unene: Maui Astronomy Club, P.O. Box 1168, 96784, Daniel O'Connell, (808) 875-0030. Founded 1986, 12 members.

Waimea: Kaua'i Educational Assoc. for Science and Astronomy, P.O. Box 161, 96796, Pete Bilbo, (808) 245-8250, observatory (18.5" scope). Monthly star parties at Barking Sands.

IDAHO

Boise: Boise Astronomical Society, P.O. Box 8386, 83707, Bill Hurtt, (208) 375- 2261. Founded 1982, 87 members. Hosts Southern Idaho Regional Star Party.

Idaho Falls: Idaho Falls Astronomical Society, 1710 Claremont Lane, 83404, Jim Ruggiero, (208) 524-6317. Founded 1966, 20 members. Hosts annual star party campout in Craters of the Moon National Monument.

Pocatello: Pocatello Astronomical Society, 1287 Kinghorn Rd., 83201, Lori Schoofield, (208) 237-0858. Founded 1977, 10 members.

ILLINOIS

Batavia: Fox Valley Astronomical Society, P.O. Box 508, 60510, Richard Klappal, (708) 844-2120. Founded 1944, 35 members, observatory with 16" Newtonian. Public viewing nights.

Champaign: Champaign-Urbana Astronomical Society, Champaign Park District, 706 Kenwood Rd., 61821, David Leake, (217) 359-6644. Founded 1986, 85 members, observatory with 16" scope. Public viewing nights. Hosts Family Skywatch.

Chicago: Astronomical Association of the University of Illinois at Chicago, Dept. of Physics, H/C 273, Box 4348, 60680, Howard Goldberg, (312) 493-1250. Founded 1991, 19 members.

Chicago: Chicago Astronomical Society, P.O. Box 30287, 60630, Michael Barrett, (312) 725-5618. Founded 1862, 140 members. Sponsors Astrofest.

Glenview: Skokie Valley Astronomers, 910 Glenwood Lane, 60025, Gretchen George, (708) 998-1627. Founded 1981, 20 members. Monthly public observing sessions.

Jacksonville: Central Illinois Astronomical Assoc., Illinois College, 62650, Frederick Pilcher, (217) 245-3412. Founded 1986, 10 members, observatory with 14" SCT. Public viewing nights.

Libertyville: Lake County Astronomical Society, 603 Dawes St., 60048, Jack Kramer, (708) 362-0959. Founded 1982, 70 members.

Lisle: Illinois Benedictine College Astronomical Society, 5700 College Rd., 60532, Robert S. Buday, (312) 969-6550. Founded 1965, 15 members, observatory with 16.5" Springfield scope.

Montgomery: Amateur Astronomers of Aurora, 69 Sheffield, 60538, Ken Timmons.

Mount Olive: Mount Olive Astronomical Society, 412 W. 4th St. S, 62069, Rev. A. Tamulis, (217) 999-2355.

Naperville: Naperville Astronomical Assoc., 9 S. 774 Route 59, 60564-9456, Drew Carhart, (708) 978-1133. Founded 1973, 78 members, observatory with 10" Newtonian. Public viewing nights.

Normal: Twin City Amateur Astronomers, P.O. Box 755, 61761, Michael Miller, (309) 452-4298. Founded 1960, 62 members, observatory with 14" scope. Hotline: (309) 438-5007.

Palatine: Northwest Suburban Astronomers, 1550 Alison Dr., 60067, Gary Poliquin. Founded 1971, 140 members.

Palos Hills: Astronomical Assoc. of the Univ. of Illinois at Chicago, 8850 W. 101st Place, 60465, Suresh K. Sreenivasan, (708) 599-2458, 34 members.

Peoria: Peoria Astronomical Society, 1125 W. Lake Ave., 61614, Mike Frasca, (309) 686-7000. Founded 1950, 95 members, observatory with 24" scope. Public viewing nights.

Quincy: Quincy Astronomical Society, 1200 St. Charles Dr., 62301, Kevin Clymer, (217) 222-6535. Founded 1981, 12 members, observatory with 16" scope. Public viewing nights.

Rock Island: Popular Astronomy Club, John Deere Planetarium, Augustana College, 61201, Paul Castle, (309) 786-6119. Founded 1936, 59 members. Weekly public viewing nights in summer.

Rockford: Rockford Amateur Astronomers, 6804 Alvina Rd., 61101, Barry or Carol Beaman, (815) 962-6540. Founded 1957, 46 members, 10" refractor. Public viewing.

INDIANA

Evansville: Evansville Astronomical Society, P.O. Box 3474, 47733, Scott Conner, (812) 424-8639. Founded 1952, 63 members, observatory with 14" SCT. Public viewing nights.

Griffith: Calumet Astronomical Society, P.O. Box 851, 46319, Stephen Miller, (219) 845-9174. Founded 1975, 110 members, observatory with 16" Newtonian. Public viewing nights. Seasonal public star parties at Lemon Lake County Park.

Mooresville: Indiana Astronomical Society, 2 Wilson Dr., 46158, J. Philip May, (317) 831-8387. Founded 1933, 150 members, observatory with 36" scope.

South Bend: Michiana Astronomical Society, P.O. Box 262, 46624, Thomas Nowicki, (219) 255-9492. Founded 1974, 20 members.

Warsaw: Warsaw Astronomical Society, R.R. 8, Box 236, 46580, Jim Tague, (219) 269-1856. Founded 1980, 30 members, observatory with 12.5" reflector. Public viewing.

West Lafayette: Wabash Valley Astronomical Society, 2367 Yeager Rd. #102, 47906, William Annis, (317) 463-3741. Founded 1970, 35 members, observatory with 14" SCT.

IOWA

Ames: Ames Area Amateur Astronomers, 1009 16th St., 50010, Jack Troeger, (515) 232-2317. Founded 1979, 85 members, observatory with 12.5" scope. Public viewing nights.

Burlington: Southeastern Iowa Astronomy Club, 601 Walnut St., 52601, Jim Blair, (319) 753-2509. Founded 1984, 92 members, observatory with 12" refractor. Monthly public viewing nights.

Cedar Rapids: Cedar Amateur Astronomers, 1513 Parkwood Lane NE, 52402, Frank Olsen, (319) 393-5758. Founded 1979, 47 members, observatory with 12.5" scope. Public viewing nights.

Davenport: Quad Cities Astronomical Society, P.O. Box 3706, 52808, William Brown, (309) 786-9622. Founded 1981, 45 members, observatory with 20" scope. Public viewing nights. Hosts Eastern Iowa Star Party.

Des Moines: Des Moines Astronomical Society, 2307 49th St., 50310, C. L. Allen. Founded 1970, 35 members, observatory with 16" scope. Public viewing nights.

Iowa City: Iowa City Amateur Astronomers, 1205 Diana Street, 52240, Donald Johnson, (319) 354-3815. Founded 1990, 80 members.

Waterloo: Cedar Valley Amateur Astronomers, 503 South St., 50701, Aaron Spurr, (319) 266-4015. Founded 1992, 32 members.

KANSAS

Kansas City: Astronomical Society of Kansas City, P.O. Box 400, Blue Springs, MO 64015, Carroll Iorg, (816) 444-4878. Founded 1936, 180 members, observatory with 30" scope. Public viewing nights. Hotline: (816) 889-STAR.

Salina: Salina Astronomy Club, 803 Mike Dr., 67401, Keith Rawlings, (913) 827-6004. Founded 1988, 18 members, observatory with 16" scope.

Topeka: Heartland Astronomical Research Team, P.O. Box 3938, 66604, Craig McManus, (913) 232-3693. Founded 1991, 6 members.

Topeka: Northeast Kansas Amateur Astronomers League, P.O. Box 951, 66601-0951, Brenda Culbertson, (913) 589-2405. Founded 1978, 45 members.

Wichita: Kansas Astronomical Observers, Wichita Children's Museum, 435 S. Water, 67202, Vicki Johnston, (316) 267-2281. Founded 1977, 30 members.

Wichita: Wichita Astronomical Society, 2100 University Ave., Friends Univ., 67213, Oscar King.

KENTUCKY

Bowling Green: Bowling Green Stargazers, 109 Pebble Court, 42101, Ross Workman, (502) 782-2173. Founded 1992, 15 members.

Fort Wright: Midwestern Astronomers, 1720 Monticello Dr., 41011, T. M. Flick, (606) 344-0264.

Golden Pond: West Kentucky Amateur Astronomers, Land Between the Lakes, 100 Van Morgan Drive, 42211-9001, Jim Boren, (615) 232-6820. Founded 1984, 20 members, observatory with 17.5" reflector. Public viewing nights. Hosts Twin Lakes Star Party.

Lexington: Blue Grass Astronomical Society, 1016 Della Dr., 40504, Bradley Canon, (606) 278-6155. Founded 1959, 25 members.

Louisville: Louisville Astronomical Society, P.O. Box 20742, 40250, Charles Allen, (502) 228-3043. Founded 1933, 75 members.

LOUISIANA

Baton Rouge: Baton Rouge Astronomical Society, 6348 Double Tree Ct., 70817, (504) 751-1685. Founded 1981, 45 members. Sponsors Space Week. Starline: (504) 344-0535.

New Orleans: Pontchartrain Astronomy Society, 820 Emerald St., 70124, Barry Simon, (504) 283-7592. Founded 1959, 173 members, observatory with 14" scope. Public viewing nights. Hosts Deep South Regional Stargaze.

Shreveport: Shreveport Astronomy Soc., 353 Ockley Dr., 71105, Jennie Goodwin, (318) 865-2433. Founded 1959, 40 members, observatory with 16" scope. Public star parties.

MAINE

Fairfield: Central Maine Astronomers, 4 Osborne St., 04937, John and Alison Meader, 14 members.

Fort Fairfield: Aroostook Astronomy Club, P.O. Box 641, 04742, Larry Berz, (207) 473-7798. Founded 1989, 12 members.

Kennebunkport: Astronomical Society of Northern New England, P.O. Box 497A, 04046, Peter Talmage, (207) 967-5945. Founded 1980, 53 members.

MARYLAND

Arnold: Anne Arundel Assoc. of Amateur Astronomers, Anne Arundel Community College, 101 College Parkway, 21012, Michael Hart, (410) 541-2271.

Baltimore: Baltimore Astronomical Society, 601 Light St., 21230, Barry Willen, (410) 833-4975. Founded 1881, 120 members.

ASTRONOMY CLUBS

Bel Air: Harford County Astronomical Society, P.O. Box 906, 21014, Larry Hubble, (410) 836-4155 (Mondays only). Founded 1970, 60 members, observatory with 16" scope. Monthly public viewing nights.

Cumberland: Cumberland Astronomy Club, 350 Bedford St., 21502, G. Frank Simpson, (301) 722-7606. Founded 1964, 30 members.

Greenbelt: Goddard Astronomy Club, Goddard Space Flight Center, Code 440.8, 20771, George Gliba, (301) 345-4760. Founded 1961, 50 members, observatory with 20" scope.

Hagerstown: Tri-State Astronomers, Washington County Planetarium, 823 Commonwealth Ave., 21740, James Taylor, (301) 791-4172. Founded 1985, 45 members. Sponsors star party at Antietam Battlefield.

Rockville: National Capital Astronomers, 10500 Rockville Pike, Apt. M-10, 20852, Leith Holloway, (301) 564-6061. Founded 1937, 265 members, observatory with 14" scope. Sponsors Exploring the Sky Star Parties.

Westminster: Westminster Astronomical Society, 3481 Salem Bottom Rd., 21157, Curtis Roelle, (410) 848-6384. Founded 1984, 75 members.

MASSACHUSETTS

Amesbury: North Shore Amateur Astronomy Club, 12 Claire Rd., 01913, David Thomas, (508) 388-2341. Founded 1989, 50 members, observatory with 12" scope. Public viewing nights.

Amherst: Amherst Area Amateur Astronomers Assoc., 1403 S. East St., 01002, Tom Whitney, (413) 256-6234. Founded 1984, 60 members, observatory with 18" Clark refractor. Public viewing nights. Hotline: (413) 256-6234.

Boston: Amateur Telescope Makers of Boston, 73 Sudbury Road, Ashland, 01721. Founded 1934, 290 members. Hotline: (508) 692-8708.

Harwich: Cape Cod Astronomical Society, P.O. Box 56, 02645, James Carlson, (508) 432-4316. Founded 1986, 60 members. Star party every clear Wednesday night.

Norwell: South Shore Astronomical Society, P.O. Box 429, Jacobs Lane, 02061, Rolf Egon, (617) 337-2572. Founded 1958, 55 members, observatory with 10" Cassegrain. Public viewing nights.

Plymouth: Bay Colony Astronomical Society, 7 Morton Park Rd., 02360, Robert A. Johnson. Founded 1990, 7 members. Owns 10" scope.

West Springfield: Springfield Stars Club, 107 Lower Beverly Hills, 01089, John E. Welch, (413) 734-9179. Founded 1948, 75 members, observatory with 20" SCT. Public viewing.

White Horse Beach: Star Searchers Astronomy Club, P.O. Box 255, 02381, Wil Curtis, (508) 759-8782. Founded 1990, 46 members. Monthly star parties. Hotline: (508) 224-6366.

Worcester: Aldrich Astronomical Society, 10 Hickory Dr., 01609, Larry Moss, (508) 752-7146. Founded 1932, 42 members, observatory with 12.5" scope. Public viewing nights.

MICHIGAN

Adrian: Astronomical Society of Lenawee County, Box 229, Hudson, 49247, Wes Boyd, (517) 547-7402. Founded 1990, 15 members, observatory with 6" scope open to the public. Hosts Public Stargaze .

Alpena: Huron Amateur Astronomers, P.O. Box 53, 49707. Founded 1989, 18 members.

Brighton: Friends United through Astronomy, 8191 Woodland Shore, Lot #12, 48116, Gary Anderson, (313) 227-9347. Founded 1982.

Detroit: Detroit Astronomical Soc., 14298 Lauder, 48227, Jack Brisbin, (313) 455-7827. Founded 1931, 50 members. Skywatchers' Hotline: (313) 837-0130.

East Lansing: Capital Area Astronomy Club, Abrams Planetarium, Michigan State Univ., 48824, David Batch, (517) 332-6381, 60 members. Sponsors AstroGanza.

Flint: Genesee Astronomical Society, Robert Longway Planetarium, 1310 E. Kearsley St., 48503, Richard Walker, (313) 627-9524. Founded 1970, 25 members. Sponsors Southern Michigan Festival of Stargazers.

Hillsdale: Astronomical Society of Hillsdale County, 500 N. Dunes Rd., 49242, Pat Calligan, (517) 439-1295. Founded 1985, 30 members, 25" scope available at Kimball Camp.

Holland: Shoreline Amateur Astronomical Assoc., 4679 46th St., 49423, Mark Logsdon, (616) 772-4904. Founded 1989, 15 members.

Kalamazoo: Kalamazoo Astronomical Society, Kalamazoo Public Museum, 315 S. Rose St., 49007, Eric Schreur, (616) 382-0326. Founded 1936, 20 members.

Lowell: Grand Rapids Amateur Astronomical Assoc., 3308 Kissing Rock Rd. SE, 49331, Evelyn Marron, (616) 897-7065.·Observatory with 17" Newtonian and 6" refractor. Public viewing nights.

Marquette: Marquette Astronomical Society, P.O. Box 761, 49855, Brian Halbrook, (906) 249-1465. Founded 1974, 30 members, observatory with 10" scope. Public viewing nights.

Midland: Sunset Astronomical Society, 4300 Washington, 48642, Bill Albe, (517) 835-4142. Founded 1974, 30 members.

Muskegon: Muskegon Astronomical Society, P.O. Box 363, 49443, Dale Johnson, (616) 798-7680. Founded 1970, 35 members, observatory with 12.5" reflector. Public viewing nights.

Petersburg: Toledo Astronomical Assoc., 8534 Covert Rd., 49270, Courtney Earhart, (313) 856-6204. Founded 1975, 35 members, observatory with 12" scope. Astronomy Day program.

Plymouth: Astronomical Society of Michigan, 11422 Waverly, 48170, Michael Best, (313) 459-2378. Founded 1985, 205 members.

Rochester: Dinosaur Hill Astronomical Society, 502 Whims Lane, 48306, Mike Bennett, (313) 651-0151. Eighteen members, 17.5" scope.

Traverse City: Grand Traverse Astronomical Society, 5999 Secor, 49684, Jerry Dobek, (616) 922-1260. Founded 1982, 32 members, observatory with 14" SCT.

Warren: Warren Astronomical Society, P.O. Box 1505, 48090, Robert Halsall, (313) 781-6784. Founded 1961, 105 members, observatory with 12.5" scope.

Ypsilanti: EMU Astronomy Club, 303 Strong Hall, Eastern Michigan Univ., 48197, Norbert Vance, (313) 487-3033. Founded 1977, 20 members, observatory (12.5" & 10" scopes). Public viewing nights.

MINNESOTA

Austin: Cedar River Astronomy Club, 407 15th St. SE, 55912, Keith Snyder, (507) 433-1903. Founded 1992, 10 members, observatory with 10" scope. Public viewing nights. Sponsors annual star party.

Brainerd: North Star Astronomy Club, 606 S. 8th St., 56401, David Starkka, (218) 829-4029. Founded 1982, 25 members.

Duluth: Arrowhead Astronomical Society, Alworth Planetarium, Univ. of Minnesota-Duluth, 55812, Glenn Langhorst, (218) 389-6212. Founded 1979, 30 members. Hosts Northern Nights astronomy activities.

Moorhead: Fargo-Moorhead Astronomical Society, P.O. Box 28, Concordia College, 56562, Jeff Struck, (218) 739-3453. Founded 1980, 12 members. Monthly public star parties for families.

Northfield: Cannon Valley Astronomical Society, 1225–330th St. E, 55057, Steve Messner, (507) 645-8347. Founded 1991, 12 members.

Pillager: Orion's Belt Astronomy Club, P.O. Box 92, 56473, Ted Venske, (612) 749-2413. Founded 1982, 35 members.

St. Paul: Minnesota Astronomical Society, Science Museum of Minnesota, 30 E. 10th St., 55101, Stuart Levy, (612) 729-9289. Founded 1975, 218 members, observatory 16" scope. Public star parties.

Willmar: Willmar Astronomy Club, 622 9th Street, SW, 56201, Patrick Thibault, (612) 235-8747. Founded 1990.

MISSISSIPPI

French Camp: Rainwater Astronomical Assoc., French Camp Academy, 39745, James Hill, (601) 547-6970. Founded 1985, 55 members, observatory with 32" scope. Public viewing nights. Sponsors Mid-South Regional Star Gaze.

Jackson: Jackson Astronomical Assoc., 6207 Winthrop Circle, 39206, Walter Rebmann, (601) 982-2317. Founded 1974, 38 members, observatory with 13" scope. Sponsors Deep South Regional Stargaze.

MISSOURI

Columbia: Central Missouri Amateur Astronomers, 261 Stardust Lane, 65201, John Winegar.

Dawn: North Central Missouri Amateur Astronomers, Route 1 Box 111, 64638, Jim Jones, 10 members.

Florissant: McDonnell Douglas Amateur Astronomy Club, 3491 Heather Trail Dr., 63031, Richard Melvin, (314) 569-4773.

Hannibal: Mark Twain Astronomical Society, 45 Pioneer Trail, 63401, William J. Remillong.

Hazelwood: Rural Astronomers of Missouri, 209C Chapel Ridge, 63042, Greg Rigelman, (314) 895-3864. Founded 1976, 22 members.

Kansas City: Astronomical Society of Kansas City, P.O. Box 400, Blue Springs, 64015, Carroll Iorg, (816) 444-4878. Founded 1936, 180 members, observatory with 30" scope. Public viewing nights. Hotline: (816) 889-STAR.

Riverside: Prairie View Astronomical Society, 931 NW Valley Lane, 64150, John Hanis, (816) 587-0054.

St. Louis: St. Louis Astronomical Society, 1846 Cedarmill Dr., 63017, Lois Fitter, (314) 532-5648. Founded 1936, 280 members. Monthly public star parties. Hotline: (314) 758-7587.

Troy: Rural Astronomers at Troy, 341 Monroe Street, 63379, Jim Marsh, (314) 528-6702. Founded 1992, 19 members, several scopes.

MONTANA

Missoula: Western Montana Astronomical Assoc., 9285 Miller Creek Rd., 59803, Bill Elison, (406) 251-4825, 20 members.

NEBRASKA

Lincoln: Prairie Astronomy Club, P.O. Box 80553, 68501, Lee Thomas, (402) 483-5639. Founded 1960, 70 members, observatory with 14" SCT. Hosts annual picnic and star party at Hyde Observatory.

Omaha: Omaha Astronomical Society, 5025 S. 163 St., 68135, Bill Jacobsen, 89 members.

NEVADA

Elko: Elko Astronomical Society, 550 S. 12th #22, 89801, Len Seymour, (702) 738-7916. Founded 1987, 25 members.

Las Vegas: Las Vegas Astronomical Society, Clark County Community College, 3200 E. Cheyenne Ave., 89030, Roger Debeuc, (702) 253-5827. Founded 1980, 60 members, 24" Dobsonian. Hosts annual Dark-Sky Observing Party.

Reno: Astronomical Society of Nevada, c/o Fleischmann Planetarium, Univ. of Nevada, Adam Kremers, (702) 784-4812. Founded 1934, 70 members, observatory with 12.5" and 24" scopes.

NEW HAMPSHIRE

Claremont: Springfield Telescope Makers, Chapel Grove, Box 434, 03734, Norman Fredrick, (603) 542-2928.

Keene: Keene Amateur Astronomers, 131 Carroll St., 03431, Paul Fisher, (603) 352-6393. Founded 1950, 35 members, observatory with 13.1" scope.

Penacook: New Hampshire Astronomical Society, 22 Center St., 03303-1448, Nelson D. LaClair, (603) 753-9225. Founded 1979, 48 members.

NEW JERSEY

Boonton: Sheep Hill Astronomical Assoc., P.O. Box 111, 07054, Evert Bono, (201) 335-5990. Founded 1972, 29 members, observatory with 16" Newtonian.

Clifton: North Jersey Astronomical Group, P.O. Box 4021, Allwood Station, 07012, Ruth Koenig (201) 778-5606. Founded 1982, 70 members, observatory with 14" SCT, lectures. Public viewing nights.

Cranford: Amateur Astronomers, 1033 Springfield Ave., 07016, George Chaplenko, (908) 549-0615. Founded 1949, 400 members, observatory with 24" scope. Public viewing nights. Hotline: (908) 276-STAR.

East Hanover: Morris Museum Astronomical Society, 6 Deforest Ave., 07936, Ronald Russo, (201) 386-1848. Founded 1962, 51 members.

Glassboro: Tychonian Observers, Rowan College, 08028, W. C. Woods, Jr., (609) 863-6336. Founded 1962, 20 members, observatory with 6" scope. Open to students only.

Glen Rock: Montclair Telescope Club, 14 Iona Place, 07452, C. Thomas Massey, (201) 447-2581. Founded 1955, 30 members.

High Bridge: New Jersey Astronomical Assoc., P.O. Box 214, 08829, Stewart Rorer, (908) 638-8500. Founded 1965, 178 members, observatory with 26" scope.

Holmdel: STAR Astronomy Society Inc., P.O. Box 547, 07733, Joseph Cascella. Founded 1957, 40 members.

Jamesburg: Concordia Astronomy Club, P.O. Box 22, 08831, Lee Domash, (609) 655-8883. Founded 1988, 130 members.

Princeton: Amateur Astronomers Assoc. of Princeton, P.O. Box 2017, 08540, Greg Mauro, (609) 585-9465. Founded 1971, 85 members, observatory with 12.5" Newtonian. Public viewing nights. Hosts Jersey StarQuest.

Toms River: Astronomical Society of the Toms River Area (ASTRA), Novins Planetarium, Ocean County College, 08754, Erik Zimmermann, (908) 255-0343. Founded 1977, 55 members.

Warren: United Astronomy Clubs of New Jersey (UACNJ), 20 Helen Street, 07059. Founded 1988, 100 members.

Warren: Warren Astronomical Society, P.O. Box 1505, 48090-1505, Robert Halsall, (313) 781-6784. Founded 1961, 105 members, observatory with 12.5" scope.

West Milford: Dark-Sky Observers, 15E Concord Rd., 07480, Ginger Payne. Founded 1991, 13 members.

Williamstown: Willingboro Astronomical Society, P.O. Box 371, Gloucester, 08030, David Neunheuser, (609) 456-3870. Founded 1960, 33 members, observatory with 14" reflector.

NEW MEXICO

Alamogordo: Alamogordo Amateur Astronomers, Box 995, Cloudcroft, 88317, Howard Brewington, (505) 687-3970. Founded 1985, 20 members, observatory with 12.5" scope. Public viewing nights.

Albuquerque: Albuquerque Astronomical Society, P.O. Box 54072, 87153-4072, Bill or Wynne Wood, (505) 296-9203. Founded 1958, 200 members, observatory with 16" Newtonian. Public viewing nights.

Clovis: Clovis Astronomy Club, 216 Sandzen, 88101, Michael Rowley. Founded 1987, 5 members.

Hobbs: Lea County Astronomical Society, NMJC Science Building, 5317 Lovington Highway, 88240, Dr. V.G. Berner, (505) 392-4510. Founded 1977, 20 members.

Las Cruces: Astronomical Society of Las Cruces, P.O. Box 921, 88004, Larry Lindsey, (505) 526-4136. Founded 1951, 65 members, observatory with 12.5" scope.

Santa Fe: Astronomy Club of Santa Fe, Santa Fe Children's Observatory, Rt. 19, Box 90-DJ, 87505, Michael Robinson, (505) 983-4011. Founded 1992, 50 members, observatory with 16" scope to open in August.

NEW YORK

Bellmore: Astronomical Society of Long Island, 801 Oak St., 11710, Alan Buckley, (516) 221-5914. Founded 1965, 115 members. Monthly observing sessions.

Black River: Northern New York Astronomical Society, RD 1, Box 149, 13612, Bill Mack, (315) 773-5807.

Buffalo: Buffalo Astronomical Assoc., Buffalo Museum of Science, Humboldt Parkway, 14211, Bill Smith, (716) 664-0841. Founded 1934, 85 members.

Chappaqua: Westchester Amateur Astronomers, P.O. Box 111, 10514, Robert Davidson, (914) 238-4533. Founded 1980, 70 members, 24" scope. Hosting "Stairway to Heaven" star party on June 18.

Clinton: Mohawk Valley Astronomical Society, Hamilton College, Box 674-B, 13323, Richard Somer, (315) 853-6056. Founded 1989, 153 members, observatory with 11" Maksutov. Monthly star parties.

Corning: Elmira-Corning Astronomical Society, 17 W. Hazel St., 14830, Marilyn L. O'Connell, (607) 962-5435. Founded 1960, 60 members.

Frewsburg: Marshal Martz Memorial Astronomical Assoc., 176 Robin Hill Rd., 14738, Tom Bemus, (716) 386-4566. Founded 1979, 45 members, observatory with 30" Newtonian. Sponsors Astronomy Weekend. Hotline: (716) 664-4506.

Getzville: Assoc. of Observational Astronomers of Western New York, 1955 Hopkins Rd., 14068, Carl Milazzo, (716) 688-4869. Founded 1989, 65 members.

Hamburg: Southtowns Astronomy Club, 145 Woodward, West Seneca, 14224, Rhonda Garbowski, (716) 649-6759. Founded 1991, 17 members. Monthly star parties.

Irvington: Polish Amateur Astronomy Club, 9 Leslie Place, Second Floor, 07111, Dan Kononczuk, (201) 374-6343. Founded 1993.

Jamesport: Custer Institute Astronomy Club, Main Bayview Rd., Southold, 11971, Barbara Lebkuecher, (516) 765-2626. Founded 1929, 150 members, observatory with 6" scope. Public viewing nights. Hosts annual Astronomy Jamboree.

Kirkville: Assoc. of Solar, Planetary & Lunar Obs., P.O. Box 95, 13082, Jim Moeller. Founded 1991, 14 members.

Lake Placid: Tri-Lakes Astronomical Society, 100 Sentinel Rd., 12946, George R. Viscome, (518) 523-2052. Founded 1986, 20 members. Weekly observing sessions in summer.

Lindenhurst: Amateur Observers' Society of New York, P.O. Box 838, 11757, Eric Barnes, (516) 242-6925. Founded 1965, 51 members. Public star parties.

Lockport: Lockport Astronomy Assoc., 7053 Northview Dr., 14094, Richard Lahrs, (716) 433-4706. Founded 1966, 25 members, Remick Memorial Observatory (12" scope). Public viewing nights.

New Paltz: Mid-Hudson Astronomy Assoc., Physics Dept., SUNY, 12561, Tom Rankin, (914) 473-7572. Founded 1987, 75 members.

New York: Amateur Astronomers Assoc., 1010 Park Ave., 10028, John Marshall, (212) 535-2922. Founded 1929, 600 members, observatory. Public star parties.

Pearl River: Rockland Astronomy Club, 110 Pascack Rd., 10965, Allan Green, (914) 735-4163. Founded 1980, 250 members, observatory with 24" scope. Public viewing nights. Sponsors Northeast Astronomy Forum. Hotline: (914) 735-7303.

Rochester: Astronomy Section, Rochester Academy of Science, P.O. Box 20292, 14602, Mark Torrens, (716) 987-5330. Founded 1932, 120 members, observatory with 12" scope.

Rochester: RIT Astronomy Club, Rochester Institute of Technology, Dept. of Physics–08, 14623. Founded 1989, 30 members.

Schenectady: Albany Area Amateur Astronomers, 1529 Valencia Rd., 12309, Bob Mulford, (518) 374-8744. Founded 1949, 100 members, owns portable 18" Dobsonian. Monthly star parties.

Syracuse: Syracuse Astronomical Society, 1115 E. Colvin St., 13210, Jos. Italiano, (315) 475-7032. Founded 1968, 110 members, observatory with 16" Newtonian. Public viewing nights. Hosts annual Summer Seminar. Hotline: (315) 472-2111.

Valley Stream: Valley Stream Astronomical Society, 14 Charles St., 11580.

Vestal: Kopernik Astronomical Society, 698 Underwood Rd., 13850, Jay Edwards, (607) 748-3685. Founded 1960, 125 members, observatory with 20" scope. Public viewing nights. Sponsors Kopernik Astronomy Fest.

NORTH CAROLINA

Albemarle: Stanly County Astronomical Society, P.O. Box 1269, 28001, Herbert Hartley, (704) 982-3728. Founded 1985, 15 members. Public star parties.

Asheville: Starfax Assoc., P.O. Box 6084, 28816, Timothy Jordan. Founded 1981, 40 members.

Castle Hayne: Cape Fear Astronomical Society, 110 Linville Dr., 28429, Paul Petty, (919) 675-2952. Founded 1983, 30 members.

Fayetteville: Astronomy Club of Cumberland County, 2308 Colgate Dr., 28304, Allen Faircloth, (919) 485-8515. Founded 1983, 20 members.

Goldsboro: Eastern Carolina Astronomy Club, 1607 Munroe Lane, 27543, Robert Krieger, (919) 778-3377. Founded 1988, 53 members.

Granite Falls: Catawba Valley Astronomy Club, Route 3 Box 472, 28630, Greg Kirby, (704) 396-7656. Founded 1976, 50 members, observatory with 10" scope. Hosts annual Blue Ridge Parkway Regional Stargaze.

Greensboro: Greensboro Astronomy Club, Natural Science Center, 4301 Lawndale Dr., 27408, Roger Joyner, (919) 288-3769. Founded 1950, 45 members, observatory with 32" scope. Public viewing nights.

Matthews: Charlotte Amateur Astronomers Club, 245 Timber Lane, 28105, Gayle Riggsbee, (704) 846-3136. Founded 1954, 75 members, observatory with 17.5" scope. Public viewing nights. Sponsors Southern Star Party.

Raleigh: Raleigh Astronomy Club, P.O. Box 10643, 27605, Mark Lang, (919) 460-7900. Founded 1979, 65 members, observatory with 24" scope.

Salisbury: Astronomical Society of Rowan County, Margaret Woodson Planetarium, 1636 Parkview Circle, 28144, Ellen Trexler, (704) 636-3462.

Thomasville: Thomasville Area Astronomy Club, 918 Alice Dr., 27360, Delbert Houston, (919) 431-5062. Founded 1986, 30 members.

Statesville: Piedmont Amateur Astronomers, RR 2 Box 181, Troutman, 28166, Ronnie Sherrill, (704) 528-9316. Founded 1988, 19 members.

Winston-Salem: Forsyth Astronomical Society, P.O. Box 30128, 27130. Founded 1937, 36 members.

NORTH DAKOTA

Bismarck: Dakota Astronomical Society, P.O. Box 2539, 58502, John Wetsch, (701) 256-3620. Founded 1987, 50 members. Hosts annual Dakota Star Watch.

OHIO

Akron: Astronomy Club of Akron, 2853 Lynne Rd., 44312, James W. Anderson, (216) 644-9314. Founded 1949, 120 members, observatory with 12.5" scope. Public viewing nights.

Chagrin Falls: Chagrin Valley Astronomical Society, P.O. Box 11, 44022, Bob Modic, (216) 731-0522. Founded 1963, 25 members, observatory with 16" scope. Public viewing nights.

Cincinnati: Cincinnati Astronomical Society, 5497 Washigo Dr., 45230, 154 members.

Cleveland: Cleveland Astronomical Society, Warner and Swasey Observatory, Case Western Reserve Univ., 44106, William Shore, (216) 461-1918.

Cleveland: Cuyahoga Astronomical Assoc., P.O. Box 29089, 44129, William Gerling, (216) 779-9779. Founded 1959, 80 members. Hosts Ohio Turnpike Astronomers Assoc. convention.

Cleveland: Lewis Astronomy Club, 21000 Brookpark Rd., MS 16-1, 44135, Martin Mayer, (216) 433-8451. Founded 1980, 10 members.

Columbus: Columbus Astronomical Society, 5280 Cape Cod Lane, 43235, Tom Burns, (614) 459-7742. Founded 1948, 200 members.

Dayton: Miami Valley Astronomical Society, 2629 Ridge Ave., 45414, Wade Allen, (513) 275-7431, 66 members.

Lima: Lima Astronomical Society, P.O. Box 201, 45802, Dave Fox. Founded 1954, 25 members, observatory, 14" scope. Public viewing nights.

Lorain: Black River Astronomical Society, 1631 Maple Dr., 44052, Michael Harkey, (216) 288-8556. Founded 1948, 50 members, observatory with 13.1" Dobsonian. Hosts annual star party.

Mansfield: Richland Astronomical Society, P.O. Box 1118, 4490, Keith Moore, (419) 468-3542. Founded 1960, 43 members, observatory with 31" Newtonian. Public viewing nights. Hosts annual Hidden Hollow star party. Hotline: (419) 524-6418.

Milford: Midwestern Astronomers, 5760 Richland Circle, 45150, Sue Rismiller, (513) 248-1577. Founded 1976, 21 members, observatory with 20" scope.

New Philadelphia: Tuscarawas County Amateur Astronomical Society, 1315 E. High Ave., 44663, Sam Krempasky, (216) 339-7335. Founded 1979, 10 members. Public star parties with a 13.1" Dobsonian.

Newton Falls: Mahoning Valley Astronomical Society, 1076 State Route 534, 44444, Mark A. Baker, (216) 537-3939. Founded 1939, 35 members, observatory with 16" Cassegrain. Public viewing by appointment. Hosts Ohio Turnpike Astronomers convention.

Ravenna: Kent Quadrangle Astronomical Society, 7353 State Route 14, Lot 12, 44266, Larry Berger.

Rossford: Northwest Ohio Visual Astronomers, 1018 E. Elmtree Rd., 43460, Frank Myers, (419) 666-8566. Founded 1990, 10 members.

Tiffin: Sandusky Valley Amateur Astronomy Club, 650 S. Washington St., 44883, Thomas Fretz, (419) 448-9377. Founded 1987, 22 members, observatory with 12.5" scope. Public viewing nights. Sponsors Wolf Creek Star Party.

Troy: Stillwater Stargazers, Brukner Nature Center, 5995 Horseshoe Bend Rd., 45373, Dick Pierce, (513) 773-7256. Founded 1985, 20 members. Star party every third Saturday.

Westerville: Westerville Astronomy Interest Group, Otterbein College, Physics Dept., 43081, Earl Phillips, (614) 764-0476. Founded 1992, 12 members, observatory, 14" scope.

Wilmot: Wilderness Center Astronomy Club, P.O. Box 202, 44689, Dave Gill, (216) 833-9399. Founded 1983, 60 members. Observes with a 16" Cassegrain.

OKLAHOMA

Ardmore: Arbuckle Astronomical Society, 713 Ash NW, 73401, Steve Girard, (405) 226-0339. Founded 1984, 25 members. Public viewing nights.

Bartlesville: Bartlesville Astronomical Society, RR 2, Box 940, 74006, Ken Willcox, (918) 333-1966. Founded 1958, 21 members. Hosts annual Prairie Star Party.

Boise City: Cimarron County Star Gazers, P.O. Box 278, 73933, Jim Rosebery, (405) 544-2222.

Enid: Northwest Oklahoma Astronomy Club, 1719 Pawnee, 73703, Dan Mathews, (405) 233-5707. Founded 1978, 55 members. Hosts annual NW Oklahoma Star Party.

Lawton: Lawton Astronomical Society, 1327 SE Clover Lane, 73501, John Johnson, or Terrence Redding (405) 536-8822. Founded 1992, 12 members.

Oklahoma City: Oklahoma City Astronomy Club, P.O. Box 21221, 73156, Beryl Cadle, (405) 789-3742. Founded 1968, 75 members. Hosts annual Okie-Tex Star Party.

ASTRONOMY CLUBS

Purcell: Central Oklahoma Astronomy Club, P.O. Box 628, 73080, Paul Frank, (405) 527-6584.

Tulsa: Astronomy Club of Tulsa, 3832 S. Victor Ave., 74105, Newell Pottorf, (918) 742-7577. Founded 1937, 105 members, observatory with 16" scope. Public viewing nights.

OREGON

Bend: Central Oregon Astronomical Society, 669 NE Lafayette, 97701, Steve Carsey, (503) 382-9058. Founded 1982, 50 members, observatory with 15" scope. Public viewing nights.

Eugene: Eugene Astronomical Society, Lane ESD Planetarium, 2300 Centennial Blvd., 97401, Cuyla Shelton, (503) 345-7748. Founded 1959, 80 members.

Portland: Rose City Astronomers, P.O. Box 91416, 97291-0416, Chuck Dethloff. Founded 1890, 275 members. Info line: (503) 629-2145. Hosts Oregon Star Party.

Roseburg: Umpqua Amateur Astronomers, Umpqua Community College, 3150 W. Military Ave., 97470, Paul Morgan, (503) 673-1081. Founded 1986, 15 members.

Veronia: Northwest Astronomy Group, 55371 McDonald Rd., 97064, Sandy Mikalow, (503) 429-2430. Founded 1980, 50 members, observatory with 14" scope. Operates a HAM radio net for amateur astronomy.

PENNSYLVANIA

Allentown: Lehigh Valley Amateur Astronomical Society, 620 E. Rock Rd., 18103, Paul Hunsburger, (908) 669-3371. Founded 1957, 200 members, observatory with 20" scope.

Beaver: Beaver Valley Astronomy Club, 1335 3rd St. #2, 15009, David Yoder, (412) 728-5255. Founded 1975, 20 members.

Clarks Summit: Lackawanna Astronomical Society, 1112 Fairview Rd., 18411, John D. Sabia, (717) 586-0789. Founded 1959, 100 members, observatory with 12.5" scope. Public viewing nights.

Duncannon: Astronomical Society of Harrisburg, RR 4, Box 4038, Motter Rd., 17020, Calvin Cassel, (717) 834-9398. Founded 1955, 160 members, observatory with 17.5" scope.

East Pittsburgh: American Lunar Society, P.O. Box 209, 15112, David Darling, (608) 837-6054. Founded 1982, 87 members.

Glenshaw: Amateur Astronomers Assoc. of Pittsburgh, P.O. Box 314, 15116, John Holtz, (412) 224-2510. Founded 1929, 250 members, observatory with 12.5" Newtonian. Public viewing nights.

Hazleton: Greater Hazleton Area Astronomical Society, P.O. Box 151, 18201, Scott McAndrews. Founded 1976, 30 members.

Kane: Sir Isaac Newton Astronomical Society, P.O. Box 591, 16735, William Kearney. Founded 1979, 10 members.

Lewisburg: Bucknell Univ. Astronomy Club, Dept. Of Physics, Bucknell University, 17837, David Lien, (717) 524-1139. Founded 1989, 15 members. Access to 10" Clark refractor. Public viewing nights.

Philadelphia: Delaware Valley Amateur Astronomers, 2220 Schlosser Road, Harleysville, 19438, Bart Thorn, (215) 584-4363. Founded 1976, 187 members. Regular public star parties.

Philadelphia: Rittenhouse Astronomical Society, 216 Elbow Lane, Haverford, 19041, Nancy Blossom, (215) 642-4337. Founded 1888, 90 members.

Reading: Berks County Amateur Astronomical Society, Reading School District Planetarium, P.O. Box 6150, Wyomissing, 19610, Linda Sensenig. Founded 1973, 50 members.

Royersford: Chestmont Astronomical Society, 275 Green St., 19468, Karl Krasley, (215) 948-9105. Founded 1989, 15 members.

University Park: Penn State Astronomy Club, 202 HUB, 16802. Founded 1973, 25 members.

Wallingford: Antique Telescope Society, 30 Green Valley Road, 19086, Walt Breyer (215) 566-2227. Founded 1990, 50 members.

Warminster: Bucks-Mont Astronomical Assoc., 1443 Devon Rd., 18974, Edward Melnick, (215) 443-7929. Founded 1984, 50 members. Hosts annual Stella-Della-Valley star party.

Warren: Warren City Amateur Astronomers Club, 118 Falconer St., 16365, Tom Traub, (814) 723-9428. Founded 1972, 8 members.

West Leechburg: Kiski Astronomers, 123 Summit Ave., 15656, Robert Yajko, (412) 842-8202. Founded 1968.

York: York County Parks Astronomical Society, 400 Mundis Race Rd., 17402, Jeri Jones, (717) 225-3744. Founded 1988, 45 members, observatory with 18" scope. Public viewing nights. Hosts annual Mason-Dixon Star Party.

PUERTO RICO

San Juan: Sociedad de Astronomía de Puerto Rico, P.O. Box 362846, 00936, Luis Maura, (809) 765-0889. Founded 1985, 90 members.

RHODE ISLAND

Newport: Celestial Observers of Rhode Island, 10 Redcross Terrace, 02840, John Hopf, (401) 521-5680, 45 members.

North Scituate: Skyscrapers, 47 Peep Toad Rd., 02857, Conrad Cardano, (401) 828-0702. Founded 1932, 125 members, observatory with 8" Clark refractor and 20" reflector. Public viewing nights.

Providence: Celestial Observers of Rhode Island, P.O. Box 40181, 02940, Ken Conca, (401) 351-5676. Founded 1985, 55 members, observatory, 22" refractor. Hosts Jerimot Hill Star Party.

SOUTH CAROLINA

Aiken: Aiken Astronomy Club, USC-Aiken, Building 106, 171 Univ. Parkway, 29801, Richard M. Albert, (803) 663-3105.

Central: Clemson Area Amateur Astronomers, 1550 Old Seneca Rd., 29630-9597, Dixon Lomax, (803) 654-3689. Founded 1982, 30 members, observatory with 29" reflector.

Greenville: Roper Mountain Astronomers, 504 Roper Mountain Rd., 29615, Doug Gegen, (803) 281-1188. Founded 1988, 100 members. Assists in operation of Daniel Observatory (23" Clark refractor). Public viewing nights.

Irmo: Midlands Astronomy Club, 112 St. Albans Rd., 29063, Jim Heilman, (803) 781-0102. Founded 1972, 55 members.

Ladson: Low Country Stargazers, 4424 Clovewood St., 29456, Danny Joe Williams, (803) 875-4260. Founded 1983, 30 members.

Rock Hill: Carolina Stargazers Astronomy Club, Museum of York County and Settlemyre Planetarium, 4621 Mt. Gallant Rd., 29732, Glenn A. Dantzler, (803) 329-2121. Founded 1986, 90 members. Open to public.

SOUTH DAKOTA

Rapid City: Black Hills Astronomical Society, 4912 Breckenridge Court, 57702, Michael O'Connor, (605) 342-3793. Founded 1956, 20 members, observatory with 12.5" Newtonian.

Sioux Falls: Sioux Valley Astronomers, 500 S. Williams Ave., 57104, Mel Pine, (605) 334-3398. Founded 1986, 25 members.

TENNESSEE

Brentwood: Barnard-Seyfert Astronomical Society, Dyer Observatory, 1000 Oman Dr., 32027, A. Heiser, (615) 373-4897. Founded 1923, 68 members. Hotline: (615) 780-3751.

Chattanooga: Barnard Astronomical Society, 838 Belvoir Hills Dr., 37412, F. Randolph Helms, (615) 629-6094. Founded 1923, 45 members, observatory with 20.5" scope. Public viewing nights.

Kingsport: Bays Mountain Amateur Astronomers, 853 Bays Mountain Park Rd., 37660, (615) 229-9447. Founded 1980, 60 members, observatory with 17.5" reflector and 8" refractor. Hosts annual Starfest.

Knoxville: Orion Research Forum and Network, P.O. Box 50291, 37950, Bob Miles, (615) 588-3087. Founded 1977, 12 members.

Knoxville: Smoky Mountain Astronomical Society, P.O. Box 53265, 37950, Paul Lewis, (615) 397-7748. Founded 1977, 40 members, owns portable 20" Dobsonian. Public viewing nights.

Manchester: Middle Tennessee Astronomical Society, 1305 Sycamore St., 37355, Donald W. Male, (615) 728-7321. Founded 1959, 8 members.

Memphis: Memphis Astronomical Society, 1229 Pallwood Rd., 38122, Richard Moore, (901) 682-2003. Founded 1956, 57 members.

Memphis: Society of Low Energy Observers, 4277 Park Forest Dr., 38141. Founded 1989, 20 low-energy members.

TEXAS

Austin: Austin Astronomical Society, P.O. Box 12831, 78711, Larry Kemp. Founded 1970, 90 members, observatory with 12.5" reflector. Public viewing nights.

Baycliff: Johnson Space Center Astronomical Society, 4802, Redfish Reef, 77518, Bill Williams, (713) 339-1367. 80 members.

Beaumont: Astronomical Society of Southeast Texas, P.O. Box 7943, 77726, Dave Deming, (409) 745-1366. Founded 1989, 30 members.

College Station: Assoc. of Amateur Astronomers, Texas A&M Univ., Dept. of Physics, 77843, Roger Smith, (409) 845-4179.

Corpus Christi: Corpus Christi Astronomical Society, 3814 Marion St., 78415-2531, Gary Mayer, (512) 852-7643. Founded 1965, 10 members.

Dallas: Texas Astronomical Society, P.O. Box 25162, 75225, Evelyn Deen, (214) 517-6980. Founded 1946, 325 members.

Ft. Worth: Fort Worth Astronomical Society, P.O. Box 161715, 76161, Jay Hornsby, (817) 451-8948. Founded 1942, 110 members, observatory with 18" scope. Public viewing nights.

Ft. Worth: General Dynamics Astronomy Club, 3400 Bryant-Irvin Rd., 76109, George Parker, (817) 294-9536. Founded 1956, 53 members, observatory with 19" scope.

Ft. Worth: Texas Observers, 1501 Montgomery St., 76107, Don Garland, (817) 732-1631. Founded 1986, 10 members. Public viewing nights.

Georgetown: Williamson County Astronomy Club, 901 S. Church St., 78626, John Upton, (512) 869-4296. Founded 1980, 30 members.

Houston: Houston Astronomical Society, P.O. Box 20332, 77225-0332, Scott Mitchell, (713) 461-3020. Founded 1955, 380 members, observatory with 14" scope.

Houston: Houston Space Society, P.O. Box 266151, 77207-6151, Richard Braastad, (713) 520-6924. Founded 1978, 50 members.

Houston: University Space Society, Univ. of Houston, Box 310 Campus Activities, Univ. Center, 77204, Alvin Carley, (713) 921-7532. Founded in 1978, 20 members, observatory with 36" and smaller scopes available.

Irving: Sidewalk Astronomers of SASI International, 3808 N. Beltline, #114, 75038-5755, Jonathan Wilkendorf, (214) 256-1513. Founded 1979, 120 members, observatory, 16" scope.

Lake Jackson: Brazosport Astronomy Club, 400 College Dr., 77566, (409) 265-3376. Founded 1985, 15 members.

Lubbock: South Plains Astronomy Club, 4803 76th St., 79424, Wayne Lewis, (806) 794-8766. Founded 1960, 25 members, assists with observatory with 26" Newtonian.

Midland: West Texas Astronomers, 2801 Metz Drive, 79705, Bruce E. Barton, (915) 694-3262. Founded 1972, 21 members.

San Angelo: San Angelo Amateur Astronomy Assoc., P.O. Box 60391, 76906, Joseph Lynch, (915) 944-2113. Founded 1964, 25 members.

San Antonio: San Antonio Astronomical Assoc., 6427 Thoreau's Way, 78239, Rick Garcia, (512) 654-9784, 73 members.

Sanger: Denton County Astronomical Society, 225 Green Springs Circle, 76266, John Love, (817) 458-7479.

Stafford: Fort Bend Astronomy Club, P.O. Box 942, 77477, Leonard Pattillo, (713) 980-1175. Founded 1984, 138 members. Hotline: (713) 980-STAR.

Texarkana: Texas High School Moonbeams Astronomy Club, 75503, Shane Mitchell, (903) 793-0041, observatory with 10" scope. Open to students only.

Texas City: College of the Mainland Astronomy Club, 1200 Auburn Rd., 77591, John L. Hubisz, (409) 938-4098. Founded 1973, 43 members.

Tyler: Astronomical Society of East Texas, Hudnall Planetarium, P.O. Box 9020, 75711, Mike Mikule, (214) 561-3710. Founded 1987, 30 members. Monthly public star parties.

Victoria: Crossroads Astronomy Club, 233 Spur Dr., 77904, Derek Newton, (512) 578-5452. Founded 1990, 12 members.

Wichita Falls: Wichita Falls Astronomy Club, 2020 Santa Fe, #10, 76309, Sandra Camp, (817) 691-2531. Founded 1990, 18 members.

UTAH

Cedar City: Southern Utah Astronomy Group, 147 S. 300 E, 84720, Brent Sorensen, (801) 586-2759. Founded 1986, 8 members, observatory with 14" SCT. Public viewing nights.

Roy: Ogden Astronomical Society, 2336 West 5650 South, 84067, Bob Tillotson, (801) 773-8106. Founded 1970, 35 members. Hosts annual Mountain States Star Party.

VERMONT

Chester: Springfield Telescope Makers, RFD #2, Box 471, 05143, John Martin, bulletin board (802) 885-3260.

Williston: Vermont Astronomical Society, P.O. Box 782, 05495, Frank Pakulski, (802) 985-3269. Founded 1964, 65 members, observatory with 16" scope. Public viewing nights.

VIRGIN ISLANDS

St. Thomas: Virgin Islands Stargazers, Flagship, 5100 Long Bay, 00802, Jeannie Kuich, (809) 774-5630. Founded 1990, 25 members, observatory with 15" scope.

VIRGINIA

Blacksburg: Astronomy Club of Virginia Tech, Virginia Polytechnic Institute, 216 Robeson Hall, 24061, John Abbott, (703) 953-0189. Founded 1970, 60 members, observatory with 14" SCT. Public viewing nights.

Bristol: Bristol Astronomy Club, 940 Reedy Creek Rd., 24201, Ken Childress, (703) 466-8404. Founded 1955, 22 members, observatory with 12.5" reflector. Public viewing nights.

Chesapeake: Back Bay Amateur Astronomers, 2808 Flag Rd., 23323, Glendon L. Howell, (804) 485-4242. Founded 1978, 17 members.

Fairfax: Northern Virginia Astronomy Club, 4415 Eastwood Court, 22032, Robert L'Hommedieu, (703) 978-0946. Founded 1980, 160 members. Hosts annual Northern Virginia Telescope Meet.

Fairfax: Nova Space Society, 4344 Mt. Carriage Lane, 22033, Jim Myska, (703) 803-7961.

Fredericksburg: Triangulum Astronomical Society, P.O. Box 7464, 22404, Mike Gill, (703) 371-2415. Founded 1983, 13 members.

Hampton: Skywatchers, 109 Mill Point Dr., 23669, Marilyn E. Ogburn, (804) 864-1175. Founded 1950, 20 members, observatory with 16" scope. Public viewing nights.

Harrisonburg: Shenandoah Valley Astronomy Club, James Madison Univ., Dept. of Physics, 22801, Henry W. Leap, (703) 568-6109.

Middletown: Shenandoah Astronomical Society, Lord Fairfax Community College, P.O. Box 47, 22645, Bill Warren, (703) 459-3510. Founded 1986, 30 members.

Nathalie: Halifax Skywatchers, P.O. Box 22, 24577, Joe Lightcap, (804) 349-3700. Founded 1986, 15 members, observatory with 13" reflector.

Portsmouth: Astronomical Society of Tidewater, 2216 Country St., 23704, Leonard Scarr, (804) 484-6152. Founded 1975, 20 members, observatory with 10" Newtonian. Public viewing nights.

Portsmouth: Tidewater Community College Astronomical Society, State Route 135, 27303, Aubrey Hartman, (804) 488-4354. Founded 1982, 50 members, observatory with 14" SCT. Public viewing nights. Hosts seasonal star parties.

Richmond: Richmond Astronomical Society, 2102 Leovey Lane, 23112, Norm Guenther, (804) 794-6413. Founded 1949, 55 members, observatory with 7.5" & 13" scopes. Public viewing nights.

Roanoke: Roanoke Valley Astronomical Society, 3721 Colony Lane SW, 24015, Frank Baratta, (703) 774-5651. Founded 1958, 75 members.

Virginia Beach: Tidewater Amateur Telescope Makers, 677 Charlecote Dr., 23464, Don Wright, (804) 424-9430. Founded 1977, 20 members.

WASHINGTON

Bellevue: Eastside Astronomical Society, P.O. Box 7482, 98008-1482, Judy Mason, (206) 746-4077. Founded 1974, 135 members. Hotline: (206) 746-3485.

Bellingham: WACO–Whatcom Assoc. of Celestial Observers, 3700 Taylor Ave., 98226, Tom Masterson, (206) 734-5821. Founded 1988.

Centralia: Southwest Washington Astronomical Society, 2421 Leisure Lane, 98531, Carl M. Newton, (206) 736-6144. Founded 1975, 20 members, observatory with 17" Dobsonian. Public viewing nights.

Everett: Everett Astronomical Society, P.O. Box 8012, 98201, James Bielaga, (206) 338-3013. Founded 1988, 35 members, 10" Dobsonian.

Keyport: Olympic Astronomical Society, P.O. Box 458, 98345, James Sykes, (206) 698-0381. Founded 1968, 70 members.

Richland: Tri-City Astronomy Club, P.O. Box 651, 99352, Barbara Rittmann, (509) 783-1845. Founded 1984, 45 members. Public viewing nights.

Seattle: Boeing Employees Astronomical Society, Boeing Support Services, Recreation Department, P.O. Box 3707, Mail Stop 4H-58, 98124-2207, Carl Brenne (206) 931-6072. Founded 1980, 75 members, 20" portable scope. Monthly meetings.

Seattle: Seattle Astronomical Society, P.O. Box 31746, 98103, Kenneth Applegate, (206) 524-3977. Founded 1950, 225 members.

Spokane: Spokane Astronomical Society, P.O. Box 8114, 99203, Thom Jenkins, (509) 838-1381. Founded 1936, 85 members.

Tacoma: Tacoma Astronomical Society, 6103-132nd St. E, Puyallup, 98371, Keith McGowan, (206) 841-1126. Founded 1931, 85 members, observatory with 15" refractor. Public viewing nights.

Yakima: Yakima Valley Astronomy Club, 1108 S. 7th Ave., 98902, William Knight, (509) 457-6410. Founded 1991, 18 members. Astronomy Day programs.

WEST VIRGINIA

Charleston: Kanawha Valley Astronomical Society, Sunrise Children's Museum, 746 Myrtle Rd., 25314, Rich Ireland, (304) 344-9620. Founded 1955, 35 members, observatory with 12.5" scope. Public viewing nights. Sponsors Blackwater Falls Astronomy Weekend, Blackwater Falls State Park.

Huntington: Ohio Valley Astronomical Society, RR 1, Box 787, South Point, OH 45680, Scott Hogsten, (614) 894-3522, 12 members. Astronomy Day programs.

Tridelphia: N.O.V.A.E., Box 436, Chapel Hill, 26059, (304) 547-5578. Founded 1989, 6 members.

WISCONSIN

Beloit: Rock Valley Astronomers, 2220 E. Ridge Rd., 53511, Carl Balke, (608) 362-0432. Founded 1950, 20 members. Sponsors Moon Watch three times a year.

Fall Creek: Chippewa Valley Astronomy Society, Hobbs Observatory, RR 2, Box 94, 54742, Bob Elliott, (715) 877-2787. Founded 1982, 30 members, observatory with 24" reflector. Hosts annual Northwoods Starfest.

Franklin: Wehr Astronomical Society, 9701 W. College Ave., 53132, Karen Kearns, (414) 425-8550. Founded 1981, 117 members. Monthly public star parties.

Grafton: Northern Cross Science Foundation, 1327–11th Ave., 53024, William Fisher, (414) 377-0468.

Green Bay: Neville Museum Astronomical Society, 210 Museum Place, 54302, Don Dewitt, (414) 468-8945. Founded 1966, 50 members, observatory with 30" Cassegrain.

La Crosse: La Crosse Area Astronomical Society, P.O. Box 2041, 54602, Robert Allen, (608) 785-8669. Founded 1978, 35 members.

Madison: Madison Astronomical Society, 404 Prospect, Waunakee, 53597, Bob Manske, (608) 849-5287. Founded 1931, 85 members, observatory with 17.5" scope.

Milwaukee: Milwaukee Astronomical Society. Founded 1932, 325 members, observatory with 25.7" Cassegrain. Public viewing nights. Info line: (414) 542-9071.

Oshkosh: NEWSTAR–Northeast Wisconsin Stargazers, 1815 Kienast Ave., 54901. Founded 1986, 60 members. Hosts Wisconsin Observer's Weekend.

Racine: Racine Astronomical Society, 63rd & Hwy. A, Yorkville, 53408, Mark Schmidt, (414) 878-2774. Founded 1956, 50 members, observatory with 16" scope. Public viewing nights.

Sheboygan Falls: Sheboygan Astronomical Society, 313 Main St., 53085, Kurt Peterson, (414) 467-2257. Founded 1973, 14 members, access to observatory with 8" scope. Public viewing nights.

WYOMING

Casper: Central Wyoming Astronomical Society, 904 N. Poplar St., 82601, Mark Hladik, (307) 577-0310. Founded 1989, 18 members.

Cheyenne: Cheyenne Astronomical Society, 6614 N. College #G, 82009, Martin Curran, (307) 635-5944. Founded 1986, 97 members. Hosts annual Weekend Under the Stars. Hotline: (307) 635-5944.

CANADA

ALBERTA

Calgary: RASC - Calgary Centre, Alberta Science Centre, P.O. Box 2100, Station M, T2P 2M5, Glenn Hawley, (403) 237-7827. Founded 1958, 200 members, observatory with 14" scope. Public viewing nights. Co-hosts Alberta Star Party.

Edmonton: RASC - Edmonton Centre, 4203–106 B Ave., T6A 2K7, Mel Rankin. Founded 1932, 120 members. Centre has 17.5" scope.

Fort McMurray: Astronomical Society of Fort McMurray, 113 Auger Court, T9J 1E5. Founded 1986, 10 members.

Lethbridge: Lethbridge Astronomy Society, P.O. Box 1104, T1J 4A2, Rick Ponomar, (403) 381-7827. Founded 1988, 32 members, observatory with 16" scope. Co-hosts annual Alberta Star Party.

BRITISH COLUMBIA

Clearbrook: Fraser Valley Astronomers Society, 2659 Valemont Crescent, V2T 3V6, Victor Pollack, (604) 850-3931. Founded 1987, 30 members.

Comox: Comox Valley Astronomy Club, 1467 Balmoral Ave., V9N 7N9, Keith Finnie, (604) 339-3720. Founded 1990, 23 members, observatory with 8" scope.

Kelowna: Okanagan Astronomical Society, 660 Cadder Ave., V1Y 5N4, Jim Failes, (604) 763-6962. Founded 1981, 75 members. Chapters in Penticton and Vernon.

Port Coquitlam: Port Coquitlam Astronomy Club, 2256 Fraser Avenue, V3B 1N9, Ted Littlewood (604) 942-9382. Founded 1992, 25 members.

Prince George: Prince George Astronomical Society, College of New Caledonia, 3330-22nd Ave., V2N 1P8, Bob Nelson, (604) 563-6928. Founded 1979, 25 members, observatory with 24" scope. Public viewing nights.

Vancouver: RASC - Vancouver Centre, Gordon Southam Observatory, 1100 Chestnut St., V6J 3J9.

Victoria: RASC - Victoria Centre, 354 Benhomer Drive, V9C 2C6, Bill Almond, (602) 478-6718. Founded 1914, 130 members. Public viewing.

MANITOBA

Brandon: West-Man Astronomy Club, 32 Ashgrove Blvd., R7B 1C2, Jeff Harland, (204) 727-3111. Founded 1985, 35 members.

Winnipeg: Manitoba Astronomy Club, 190 Rupert Ave., R2H 1S5, Bert Valentin, (204) 988-0625. Founded 1982, 40 members.

Winnipeg: RASC - Winnipeg Centre, P.O. Box 215, St. James Post Office, R3J 3R4. Operates Glenlea Observatory (14" SCT).

NEWFOUNDLAND

St. John's: RASC - St. John's Centre, 206 Frecker Dr., A1E 5H9, Randy Dodge.

NOVA SCOTIA

Halifax: RASC - Halifax Centre, 1747 Summer St., B3H 3A6, Nat Cohen, (902) 434-3103. Founded 1955, 150 members. Hosts annual Nova East Star Party.

Sydney River: Cape Breton Astronomical Society, 131 Green Acres Dr., B1S 1K5, John Reppa, (902) 562-2772. Founded 1986, 40 members. Hosts annual Highland Star Party.

ONTARIO

Kingston: RASC - Kingston Centre, P.O. Box 1793, K7L 5J6, Kim Hay, (613) 353-1189. Founded 1961, 48 members. Public observing with 10" Newtonian.

London: RASC - London Centre, P.O. Box 842, Station B, N6A 4Z3, Eric Clinton, (513) 453-3198. Founded 1922, 45 members.

Niagara Falls: RASC - Niagara Centre, P.O. Box 241, L2E 6T3, Charles Fassel, (416) 935-3227. Founded 1958, 45 members, observatory with 17.5" scope. Public viewing nights.

North Bay: North Bay Astronomy Club, 50 Van Horne Cr., P1A 3L3, Merlin Clayton, (705) 472-1182. Founded 1985, 20 members. Sponsors annual Gateway to the Universe camping weekend and star party.

North York: Students for the Exploration & Development of Space, York Student Centre, 4700 Keele Street, M3J 1P3, H. Peter White, (416) 650-9890. Founded 1989, 100 members.

Ottawa: RASC - Ottawa Centre, P.O Box 6617, Station J, K2A 3Y7, Doug George, (613) 225-7182. Founded 1906, 250 members, observatory with 16" reflector.

Sarnia: RASC - Sarnia Centre, 1019 Emily St., Mooretown, N0N 1M0, Alice Lester. Founded 1980, 15 members.

Scarborough: Metropolitan Toronto Astronomical Society, 154 John Tabor Trail, M1B 2P8, S. Spinney.

Sudbury: Sudbury Astronomy Club, 859 Chestnut Crescent, P3A 5B3, Fred Boyer, (705) 560-3265.

Thunder Bay: RASC - Thunder Bay Centre, 135 Hogarth St., P7A 7H1, Bob Bishop, (807) 767-5689. Founded 1987, 38 members. Sponsors Naturalist of the Night at Sleeping Giant Provincial Park.

Toronto: North York Astronomical Assoc., 26 Chryessa Ave., M6N 4T5. Founded 1980, 50 members, observatory with 16" Dobsonian. Hosts annual Starfest.

Toronto: RASC - Toronto Centre, McLaughlin Planetarium, 100 Queen's Park, M5S 2C6, Tony

Harvatin. Founded 1868, 700 members. Hotline: (416) 724-STAR.

Waterdown: RASC - Hamilton Centre, P.O. Box 1223, L0R 2H0, Patricia Marsh, (416) 575-4191. Founded 1909, 90 members, observatory with 17" scope. Public viewing nights.

Waterloo: RASC - Kitchener-Waterloo Centre, 114 Westvale Dr., N2T 1J2, Paul Bigelow, (519) 888-7516. Founded 1980, 30 members, observatory with 14" scope. Group observing by reservation.

Windsor: RASC - Windsor Centre, 5450 Haig Ave., N8T 1K9, Joady Ulrich, (519) 945-3132. Founded 1945, 45 members.

PRINCE EDWARD ISLAND

Summerside: Athena Community Astronomy Club, P.O. Box 2500, C1N 4L9. Fifty members.

QUÉBEC

Albanel: Société Astronomique de Dolbeau, 151 Rang "B," G0W 1A0, Alain Lavertu, (418) 276-5661.

Chambly: Club d'Astronomie de Chambly, 1 269 rue Breux, J3L 2Y2, René Léger, (514) 658-1393.

Chicoutimi: Club d'Astronomie Sirius, C.P. 1613, G7H 6Z5, Claude Boivin, (418) 690-0619.

Coaticook: Club d'Astronomie de Coaticook, 10 rue Main ouest, J1A 1P2, Gilles Garant, (819) 849-3608.

Dorval: C.D.A.D.F.S., 330A Georges V, H9S 3T1, Lorraine Morin, (514) 633-0703.

Drummondville: Club d'Astronomie Drummondville Inc., C.P. 53, J2B 6V6, Ghislain Chagnon, (819) 472-5760.

Gatineau: Club d'Astronomie Nova de Gatineau, 28 rue Beausoleil, J8T 7H3, Daniel Rollin, (819) 569-6997.

La Pocatiére: Club d'Astronomie du CEGEP de La Pocatiére, 140 4iéme Avenue, G0R 1Z0, Louis Théberge, (418) 856-1525.

La Salle: Les Observateurs de la Magnitude Absolue, 9 070 rue Boivin, H8R 2E4, Gaétan Cormier, (514) 367-0318.

Laval: Club des Astronomes Amateurs de Laval, C.P. 214 Succ. St. Martin, H7V 3P5, Christian Villemaire, (514) 967-1552.

Longueuil: Club du Astronomes Amateurs de Longueuil, 941 des Pinsons, J4G 2L8, Gerald Brassard, (514) 646-1177. Founded 1985, 30 members, several scopes.

Longueuil: Club d'Astronomie de Longueuil, 2 495 rue Bellerose, app. #305, J4L 4H8, Yves Morissette, (514) 468-4739. Founded 1985, 40 members, observatory with 16" scope.

Lévis: Club d'Astronomie du CEGEP Lévis-Lauzon, 205 rue Mrg. Bourget, G6V 6Z9, Jacky Filion, (418) 833-5110.

Montréal: Club d'Astronomie Espace de Montréal, 8530 boul. Lacordaire, Saint Leonard, H1R 2A7, François Quesnel, (514) 322-7587. Founded 1983, 20 members.

Montréal: Fédération des Astronomes Amateurs du Québec, 4545 Ave Pierre-de Coubertin, C.P. 1000, Succ. M, H1V 3R2, Jean Marc Richard, (514) 252-3038. Founded 1975, umbrella organization of 30 clubs totaling 600 members. Hosts Annual Congress of FAAQ.

Montréal: RASC - Le Societé d'Astronomie de Montréal, P.O. Box 206, Station St. Michel, H2A 3L9, Patrice Gerin-Roze, (514) 421-7300. Founded 1947, 230 members, observatory with 8" scope. Public viewing nights. Hosts annual CAFTA Conference, a Québec "Stellafane."

Montréal: RASC - Montréal Centre, P.O. Box 1752, Station B, H3B 3L3, Louie Bernstein, (514) 845-2612. Founded 1918, 130 members, observatory with 14" SCT. Public viewing nights.

Montréal: Soc. des Jeunes Astronomes Amateurs de Montréal, 2920 rue Lyall, H1N 3G9, Dany Durand, (514) 589-9687.

Otteburn-Park: Club d'Astronomie de Béloeil, 834 rue Mason, J3H 2B7, Fernande Turcotte, (514) 464-8952.

Rimouski: Club d'Astronomie de l'U.Q.A.R., 300 ave. Des Ursulines Local #E205, G5I 3A1, Jean-Paul Caron, (418) 723-4402.

Rock Forest: Club des Astronomes Amateurs de Sherbrooke, 4 221 rue Varenne, J1N 1X5, Iann St. Pierre, (819) 565-3594. Founded 1981, 27 members. Sponsors Val-Estrie Camp.

Rouyn-Noranda: Les Almucantars, 425 boul. du Collége C.P. 1500, J9X 5E3, Sébastien Gauthier, (819) 280-4459.

Shawinigan: Club d'Astronomie du CEGEP de Shawinigan, 2 263 Bou. du Collége, G9N 6L1, Réjean Launier/J.P. Grenier, (819) 539-4831.

Sorel: C.A.P. vers les étoiles, 323 rue Lapierre, J3P 5J1, Carl Miville, (514) 743-4710. Founded 1991, 19 members. Public viewing nights.

Ste-Denis-sur-le-Richelieu: Club Céleste de Ste-Denis-sur-le-Richelieu, 354 Chem. Des Patriotes, J0H 1K0, Etienne Marcoux, (514) 787-2241.

Ste-Foy: RASC - Québec Centre, Casier Postal 9396, G1V 4B5, Alain Daigle, (418) 832-4100. Founded 1942, 100 members, observatory with 14" scope. Public viewing nights.

Ste-Monique de Mirabel: Club d'Astronomie Mira, 15 951 Rang St-Henri, J0N 1R0, Pedro Borquez/Mariette Croteau, (514) 475-7039.

Trois-Rivières-Ouest: Club d'Astronomie Jupiter, 5 610 rue Marseille, G8Y 4M3, Thomas Collin, (819) 373-0266. Founded 1981, 25 members, observatory with 16" scope.

Valleyfield: Club d'Astronomie Orion de Valleyfield, 409 rue Jacques Cartier, J6T 4T7, Yvan Prégent, (514) 377-2493.

Verdun: Club desc Astronomes Amateurs de Verdun, 3 178 rue Verdun, Victor Lefebvre, (514) 767-7011.

Ville St-Georges: 2 121 119iéme Rue, G5Y 5S1, Jacques Pomerieau, (418) 228-8964.

SASKATCHEWAN

Regina: RASC - Regina Centre, Box 20014, 2102 11th Ave., S4S 7E6, (306) 352-8515. Founded 1910, 30 members, observatory with 16" reflector. Public viewing nights.

Saskatoon: RASC - Saskatoon Centre, Box 317, Sub. P.O. Box #6, S7N 0W0, Mike Wesolowski, (306) 373-0137. Founded 1968, 45 members, observatory with 12.5" scope.

MÉXICO

México City, D.F.: Sociedad Astronómica de México, A.C., Isabel la Católica y Cádiz, Col. Alamos, Apartado Postal M-9647. Contact: Eric Roel; Phone: 519 47 30. Founded 1902, observatories with 24" Cassegrain, 14" SCT, 12.5" reflector, 8" and 6" refractors.

ASTRONOMY ORGANIZATIONS

Amateur Satellite Observers, HCR 65, Box 261-B, Kingston, AR 72742, Jim Hale.

American Association of Variable Star Observers, 25 Birch St., Cambridge, MA 02138, Janet Mattei, (617) 354-0484. Founded 1911, 1,100 members.

American Astronomical Society, 2000 Florida Ave. NW, Suite 300, Washington, DC 20009, Peter B. Boyce, (202) 328-2010.

American Lunar Society, P.O. Box 209, East Pittsburgh, PA 15112, Francis Graham, (412) 829-7455. Founded 1982, 94 members, observatory with 7" refractor.

American Meteor Society, Dept. of Physics - Astronomy, SUNY — Geneseo, Geneseo, NY 14454, David Meisel, (716) 245-5282. Founded 1911, 50 members. E-Mail: EISEL@GENESEO (Bitnet).

Association des Groupes d'Astronomes Amateurs, 4545 Pierre-de-Coubertin, C.P. 1000, Succ. M, Montréal, Québec, CANADA, H1V 3R2, Jean-Marc Richard, (514) 252-3038. Founded 1975. Umbrella organization of 30 astronomy clubs in Québec with total membership of 700.

Association of Lunar and Planetary Observers, P.O. Box 143, Heber Springs, AR 72543, Harry Jamieson, Membership Secretary, (501) 362-7264. Founded 1947, 600 members.

Astronomical Association of Northern California, 4917 Mountain Blvd., Oakland, CA 94619-3014, Don Stone, (510) 376-3007. Founded 1971. Umbrella organization of 22 clubs. Send SASE for 1993 Resource Guide.

Astronomical League, Science Service Building, 1719 N. Street NW, Washington, DC. Founded 1947, 12,000 members.

Astronomical Society of the Pacific, 390 Ashton Ave., San Francisco, CA 94112, Robert Havlen, (415) 337-1100. Founded 1889, 7,000 members. National organization of professional and amateur astronomers. Annual conference this year in San Diego, California, July 10 - 15 cosponsored by ASTRONOMY magazine.

Astronomy Day Headquarters, Chaffee Planetarium, 54 Jefferson SE, Grand Rapids, MI 49503, Gary Tomlinson, (616) 784-9518. Founded 1973. Coordinates National Astronomy Day. Extensive handbook available to assist clubs.

Aurora Alert Hotline, 25 Manley Dr., Pascoag, RI 02859, David A. Huestis, (401) 568-9370. Founded 1978, 150 members.

Earthwatch, Box 403, Watertown, MA 02272, Blue Magruder, (617) 926-8200. Founded 1971, 60,000 members. Sponsors scientific field research worldwide.

Group 70/Large Amateur Telescope Project, 2331 American Ave., Hayward, CA 94545, Denni Medlock, (510) 278-6563. Founded 1988, 150 members.

International Amateur-Professional Photoelectric Photometry, Dyer Observatory, 1000 Oman Drive, Brentwood, TN 37027, Douglas S. Hall, (615) 373-4897. Founded 1980, 1,115 members.

International Dark-Sky Association, 3545 North Stewart, Tucson, AZ 85716, David Crawford. Founded 1988, 1,200 members. Promotes awareness of light-pollution problem and its solutions. Literature available.

International Meteor Organization (North America), 181 Sifton Ave., Fort McMurray, Alberta, CANADA, T9H 4V7, Peter Brown, (403) 743-8625. Founded 1988, 600 members worldwide. Coordinates reports from meteor observers. Publishes bimonthly journal.

International Occultation Timing Association, 2760 SW Jewell Avenue, Topeka, KS, 66611-1614, Craig or Terri McManus, (913) 232-3693. Founded 1974, 350 members.

International Planetarium Society: Salt Lake City Astronomical Society, Hansen Planetarium, 15 S. State St., 84111, (801) 531-4952. Founded 1971, 190 members, observatory with 16" scope. Public viewing nights. Hotline: (801) 532-STAR.

National Deep-Sky Observers Society, 1607 Washington Blvd., Louisville, KY 40242-3539, Alan Goldstein, (502) 426-4399. Founded 1976, 90 members.

National Space Society, 922 Pennsylvania Ave. SE, Washington, DC 20003, Aleta Jackson, (202) 543-1900.

Problicom Sky Survey and Nova Patrol, 1940 Cotner Ave., Los Angeles, CA 90025, Ben Mayer, (310) 472-8853. Founded 1975, 500 members.

Royal Astronomical Society of Canada, 136 Dupont Street, Toronto, Ontario, CANADA, M5R 1V2, (416) 924-7973. Founded 1890, 3,200 members. Local Centres across Canada. E-mail: ASC@VELA.ASTRO.UTORONTO.CA (Internet).

Small Scope Observers Association, 4 Kingfisher Place, Audubon Park, NJ 08106, Robert Browning, (609) 547-9487. Founded 1986, 116 members.

Society of Amateur Radio Astronomers, 247 North Linden St., Massapequa, NY 11758, Vincent Caracci, (516) 798-8459. Founded 1981, 270 members. Annual convention in June, Green Bank, WV.

Spaceweek National Headquarters, 1110 NASA Road 1, Suite 100, 77058, Dennis Stone. Founded 1981.

Sunsearch Supernova Patrol, 14400 Kolin Ave., Midlothian, IL 60445, Steve H. Lucas, (708) 396-1499. Founded 1985, 25 members.

The Meteoritical Society, Dept. of Geological Sciences, Univ. of Tennessee, Knoxville, TN 37996. Founded 1933, 850 members.

The Planetary Society, 65 North Catalina Ave., Pasadena, CA 91106, Susan Lendroth, (818) 793-5100. Founded 1980, 125,000 members.

Webb Society (North America), 1440 S. Marmora Ave., Tucson, AZ 85713-1015, Ronald J. Morales, (602) 628-1077. Founded 1967, 330 members. Organization of deep-sky observers. Call 4 to 7 p.m. or on Sundays for information.

Western Amateur Astronomers, 4135 Pickwick Drive, Concord, CA 94521, Jack Borde. Founded 1949.